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CONTRACTING ORGANIZATION: Society for Medical Simulation  
Santa Fe, NM 87501-1850

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# STA 2005

*Hot Tech in Anesthesia:  
Making Capital Equipment Decisions*

5th Annual  
International Meeting on  
Medical Simulation:  
*Simulating Change Together*



Radisson Miami Florida  
January 13-16, 2005

Sponsored by the Society for Technology in Anesthesia

**[www.AnesTech.org](http://www.AnesTech.org)**

# Society for Technology in Anesthesia

The Society for Technology in Anesthesia (STA) is an international membership-based non-profit organization. Members are physicians, engineers, students and other non-physicians who represent the users, teachers and developers of anesthesia-related technologies, computing, and simulators. STA has two official Component Sections, a Section on Computing and a Section on Simulation each of which is responsible for a scientific meeting, plus several less formal Special Interest Groups.

The Society for Technology in Anesthesia (STA) is pleased to be a Component Society of the IARS and the sponsor of a new Section in *Anesthesia and Analgesia* on Technology, Computing and Simulation. *Anesthesia and Analgesia* is STA's Official Journal.

## 2004 STA Board of Directors

### President

Jeff Feldman *University of Pennsylvania*

### Immediate Past President

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### STA @ ASA Activities

Butch Loeb *University of Arizona*

### Computers in Anesthesia XXV

Susan Feather *MD Anderson*

### Newsletter

Jim Szocik *University of Michigan*

### Research/Grant Awards

Kirk Shelley *Yale University*

### Website

Butch Loeb *University of Arizona*

### 2005 Annual Meeting

George Blike *Dartmouth*

## STA Program Activities

### Annual Scientific meeting (January)

#### STA @ ASA Events

#### ASA Breakfast Panel

#### STA Dinner and N. Ty Smith Lecture

### Computers in Anesthesia Meeting (October)

#### *Immediately following the ASA*

### Annual J.S. Gravenstein Technology Award

#### *Interface: STA's electronic newsletter*

#### STA Research Grants

Society for Technology in Anesthesia  
PMB 300 223 N. Guadalupe  
Santa Fe, NM 87501



[www.AnesTech.org](http://www.AnesTech.org)



# **Society for Technology in Anesthesia**

**STA 2005:**

**Hot Tech in Anesthesia: Making Capital Equipment Decisions  
&**

## **Society for Medical Simulation**

**2005 International Meeting on Medical Simulation:**

**Simulating Change Together**

**Radisson Miami, Florida**

On behalf of the program committees and the Boards of Directors, welcome to this year's meetings. We would personally like to thank the outstanding faculty who have generously given their time to prepare and present their lectures, workshops and demonstrations.

Please make every opportunity to network with our exhibitors, faculty and members during the meeting. This type of learning is important and beneficial to everyone. STA is a unique organization whose members represent the practice of anesthesiology as well as industry involved in development and production of technologies used by anesthesiologists in education and medical care. Interaction between the members is a strength of STA. If you are interested in becoming more active in STA and its educational programs, please contact one of the Board members. We welcome participation and involvement at all levels.

**Accreditation:** This activity has been jointly planned and implemented in accordance with the Essentials and Standards of the Accreditation for Continuing Medical Education. The Society for Technology in Anesthesia is accredited by the ACCME and takes responsibility for the content, quality and scientific integrity of this CME activity. STA designates this activity for a maximum of 23 CME hours in Category 1 Credit towards the AMA Physician's Recognition Award. Each physician should claim only those hours of credit that he/she actually spent in the educational activity.

**Evaluation:** It is extremely important that you complete the evaluation form so that we might improve our educational programs and provide you with education that meets your needs. We are especially interested in any conflict of interest you may perceive that has not been appropriately disclosed.

**CME certificate:** Your CME certificate is enclosed with your on-site registration packet. *Keep for your records.*

**Meal functions and special events:** Please be sure to wear your name tag and present a ticket for all conference functions. Lost tickets will not be replaced.

### **STA 2005**

George Blike, Chair

Charlotte Bell, President-Elect

Kirk Shelley, Research Committee Chair

### **Int'l Meeting on Medical Simulation**

William Dunn, Lisa Sinz, & Stefan Moenk

Co-Chairs

Michael DeVita, Research Chair

Richard Riley, Simulation Workshop Chair

## **2006 Dates**

**STA 06 – January 19-21, 2006 (Thurs-Sat)**

**Hilton Hotel, San Diego**

**IMMS – January 14-17, 2006 (Sat-Tues)**

**Sheraton, San Diego**

## STA 2005: At a Glance

### Wednesday, January 12

10:00 – 3:00 STA Board of Directors meetings

### Thursday, January 13

7:00am Continental Breakfast  
8:00 Welcome and Introductions  
8:15 **Keynote Address: The Promise of New Anesthesia Technologies...Techno-fantasy vs. Tangible Improvements**  
9:00 **Hot Tech Topic #1: Portable Ultrasound**  
12:00pm STA Business meeting and presentation of J.S. Gravenstein Award  
5:00 **Research Session I: Oral Presentations**  
5:30 **Research Session II: Professor Rounds Posterside**  
5:30 **Plug & Play Work Group**

7:00 Welcome Reception for both STA & IMMS

### Friday, January 14

7:00am Continental Breakfast with Exhibitors and Posters  
8:00 **Joint Session: STA and IMMS**  
**Socio Technical Simulation & Care Process Transformation**  
9:30 Technology Showcase and poster viewing  
10:30 **Hot Tech Topic #2: Non-OR Anesthesia Technologies (NORA)**  
1:00pm **Art Deco Tour – Tickets required**  
5:30 **Show and Share – Anesthesia Technology Applications for Handhelds, Laptops, Office or Home**

7:00 **Changes in Attitude – Changes in Latitude - Gathering**  
7:30 **Doors to Margaritaville Open**

### Saturday, January 15

7:00am Continental Breakfast with Exhibitors  
8:00 **Hot Technology Review 2005**  
9:15 Technology Showcase  
11:00 **Keynote Address II: Genomics, a Critical Anesthesia Technology in the Future**  
12:00 Adjourn meeting

### STA Committee Meetings:

These are initial meetings of new committees. The Chair may select additional times to meet during the course of the STA meeting further the work of the committee. All interested STA members are invited to attend any and all .....and become involved.

**Wireless Technology** Thursday, January 13: 9:30 am  
**Technology Education** Friday, January 14 9:30 am  
**On-Line Tech Review** Friday, January 14 12 noon pm

## 2005 Int'l Simulation Meeting At a Glance

### Thursday, January 13

7:00 pm Welcome Reception for both STA and IMMS

### Friday, January 14

7:00 am Continental Breakfast with Exhibits and Poster viewing  
8:00 **Joint Session: STA and IMMS**  
**Socio Technical Simulation & Care Process Transformation**  
9:30 Technology Showcase in Exhibit Area  
10:00 **General Session I Keynote Education Address**  
11:00 **General Session II: Bridge Between Education & Technology**  
12:00pm IMMS Luncheon and SMS Annual Meeting  
1:30 **Concurrent Sessions**  
**General Session III: Pediatrics, OB & NeoNatal**  
**General Session IV: Evaluation & Assessment**  
Technology Showcase, Posters & Demonstrations  
3:00 **Workshops:** Registrants will be able to rotate through their choice of four workshops.  
3:15 **Roundtable: Education Research**  
4:30 **Roundtable: Research Funding Opportunities**  
7:00 **Changes in Attitude – Changes in Latitude - Gathering**  
7:30 **Doors to Margaritaville Open**

### Saturday, January 15

7:00am Continental Breakfast with Exhibitors and Poster Viewing  
8:00 **Concurrent Sessions**  
**General Session V: Teamwork**  
**General Session VI: Education**  
9:30 **Poster Presentations I** followed by at-poster viewing  
9:30 **Technical Workshops**  
11:00 **Poster Presentations II** followed by at-poster viewing  
11:30 Box Lunch  
11:30 **Roundtable: Building a Simulation Center: Lessons Learned**  
1:00pm **Concurrent Sessions**  
**General Session VII: Building Bridges: Interdisciplinary Simulation**  
**General Session VIII: Validation of Simulation**  
3:15 **Workshops:** Registrants will be able to rotate through their choice of workshops  
3:45 **Roundtable: Soliciting National Support for Medical Simulation**  
5:00 **Roundtable: Formation of a Simulation Journal**  
5:30 **Roundtable: Sim Center Directors**

### Sunday, January 16

07:00 Continental Breakfast  
08:00 **Concurrent Sessions**  
**General Session IX: Performance Assessment**  
**General Session X: Future Technology**  
11:00 **General Session XI: Simulation Drivers: Where are we Headed?**  
12:00 Adjourn meeting

**Wear your nametag!**  
**Tickets are required for all**  
**luncheons & banquet**

**Society for Technology in Anesthesia & Society for Medical Simulation**  
PMB 300 223 N. Guadalupe Santa Fe, NM 87501

We would like to recognize our corporate supporters for 2005. These companies have made our educational and research activities possible.

## **Platinum**

G.E. Healthcare  
Draeger Medical  
Medical Education Technologies Inc.

## **Gold**

Laerdal  
Masimo

## **Silver**

Clarus Medical  
Criticare Systems Inc.  
DocuSys  
Gaumard Scientific  
Immersion Medical  
IngMar Medical  
Masimo Corp.  
SunMedical/Wiser Institute

## **Friends of STA**

Aspen Medical Products  
GASNet  
Limbs and Things

Michigan Instruments  
Philips Medical Systems  
Simbionix  
Sonosite

## **Simulation Centers**

Center for Medical Simulation  
Center for Simulation Technology & Academic Research

# **STA 2005 & International Meeting on Medical Simulation Exhibitor Information**

## **Aspen**

Aspen Medical Products is a leader in the development of innovative spinal immobilization products used for post-trauma stabilization, rehabilitation, pre-and post-surgical stabilization, and pain management. Aspen© Spinal Bracing Systems provide innovative patient care, unsurpassed motion restriction and superior comfort that encourage better patient compliance

## **Clarus Medical**

Shikani Optical Stylet™(SOS) a new, reusable, portable, high-resolution fiberoptic endoscope for difficult intubations. Adult (Endotracheal tubes ≥5.5-mmID) and Pediatric (Endotracheal tube 2.5-5.0-mmID) sizes.

The Flexible Airway Scope Tool™ (FAST) is used for visual confirmation or checking patency of ET tube placement as small as 4.0-mm ID, used to view and ventilate while positioning a LMA fastrach.

## **GE Healthcare**

GE Healthcare provides transformational medical technologies that will shape a new age of patient care. GE Healthcare offers a broad range of services to improve productivity in healthcare and enable healthcare providers to better diagnose, treat and manage patients. For more information about GE Healthcare, visit [www.gehealthcare.com](http://www.gehealthcare.com).

## **DocuSys**

DocuSys, providing comprehensive digitization of anesthetics, incorporates customizable decision support, professional fee capture, comorbid condition documentation and automatic documentation, tracking and billing of drugs to maximize quality and financial return. The system incorporates an intravenous drug monitor, DocuJect®, which utilizes bar-coding and digital imaging to digitize drug delivery data.

## **Draeger Medical**

Draeger Medical, Inc. is a leader in design, engineering and manufacturing of Anesthesia Systems, Patient Monitors, Critical Care Systems as well as Information Management Systems. Draeger Medical has been a supporter of the Society for Technology in Anesthesia for many years and most recently participated in the ASA Breakfast panel presenting their newest technologies in a "Meet the Press" format.

## **Gaumard**

Gaumard is a Miami FL company providing simulators for healthcare education worldwide. Our more than 200 proprietary products include the HAL mobile simulator for team training, the NOELLE for obstetric/neonatal training, the SOE for gynecological training and the CHOLE for nursing programs. Visit our exhibit booth and meet HAL and NOELLE plus some of newborn simulators that change color based upon the quality of resuscitation efforts.

## **Immersion Medical**

Immersion Medical is the leader in developing, manufacturing, and marketing simulators that recreate realistic medical procedures. These simulators allow healthcare providers to practice procedures in an environment that poses no immediate risks to patients, where mistakes have no dire consequences, animal use is avoided, and performance standards for specific procedures are raised. Healthcare professionals can choose from a range of medical situations while experiencing real-life sight, sounds and touch sensations. Using advanced 3-D computer graphics, high-fidelity sound and state-of-the-art tactile feedback, these medical simulations reproduce the real experience.

## **IngMar Medical Ltd.**

IngMar Medical was established in 1993 to meet a growing need for portable and more versatile lung simulation devices for use in respiratory care training as well as respiratory device development, research and evaluation. Increasing technological sophistication in mechanical ventilation requires more extensive training for respiratory care personnel. Addressing a need for portable, easy-to-use lung models, IngMar Medical developed its Neonatal and Adult/Pediatric Demonstration Lung Models. Schools of respiratory therapy, hospitals, ventilator manufacturers and distributors value these models' ability to provide a strong visual impression to enhance their demonstration and training.

## **Laerdal Medical Corporation**

Dedicated to helping save lives, Laerdal provided products, services and system solutions for COR, BLS, and ACLS Training as well as a full line of Pre-Hospital products including Airway Management, Suction, Spinal Motion Restriction and Defibrillation. Laerdal is a major supporter of IMMS workshops providing equipment and services.

## Limbs and Things

Limbs & Things supplies training and demonstration materials for healthcare professionals, incorporating synthetic soft tissue models, multimedia training systems and a design & build service. *Synthetic soft tissue models:*

Our models have been specifically designed for 'hands-on' structured and staged clinical, surgical and medical skills training. They offer variations in anatomy, and provide for increasing levels of technical and procedural difficulty, meeting the needs of educators and trainees. *Multimedia training system:* In conjunction with our sister company Medical Skills Ltd, Limbs & Things offers model training with multimedia. Our integrated multimedia system consists of Trainer Editions and Trainee Kits. The Trainer products are for use by the educator. The self-contained Trainee Kits are for pre and post course learning by trainees

## Masimo Corporation

Masimo Corporation is the innovator and leader of motion and low perfusion tolerant pulse oximetry. Over 70 independent and objective studies have demonstrated the superior performance of Masimo Signal Extraction Technology®. (Masimo SET™). Masimo licenses Masimo SET technology to over 35 patient monitoring companies representing 70% of the world's pulse oximetry shipments.

## Medical Education Technologies Inc.

The METI Human Patient Simulator (HPS™) represents the latest in the state of the art simulation technology for training clinicians at all levels of medical education. Sophisticated mathematical models of human physiology and pharmacology determine automatically the patient's response to user actions and interventions. With dynamic coupling of the cardiovascular, pulmonary and pharmacological models along with the physical embodiment of the mannequin, the simulator allows for the complete characterization of the real patient. METI is a workshop supporter and provides generous support for the Gravenstein Technology Award and luncheon and the annual meeting banquet.

## Michigan Instruments

Michigan Instruments is a quality driven organization rooted in a tradition of excellence, with a global emphasis on offering precision instrumentation for the respiratory care and emergency medicine markets. We are a flexible organization committed to employing our core competencies to meet the ever-increasing demands in the markets we serve, for a higher level of patient care and safety

## Simbionix

Simbionix mission is to provide state of the art, computer-assisted medical simulation training systems, and set the standard for minimally invasive surgical training and performance. We especially aim at the new multidiscipline medical training centers, which utilize training laboratories. The Simbionix team, developed the company's first product, the GI Mentor™, a computer-based simulator for training endoscopic procedures skills. Other medical training simulators which provide medical experts with hands-on training in Minimally Invasive Surgery procedures; the URO Mentor™ - a simulator for endourology procedures, the PERC Mentor™ for percutaneous access procedures, the LAP Mentor™ - a multi disciplinary simulator for laparoscopic skills and surgery procedures, and the ANGIO Mentor™, a multidisciplinary simulator that provides hands-on practice in an extensive and complete simulated environment of interventional endovascular procedures.

## Center for Medical Simulation

The Center for Medical Simulation is a not-for-profit corporation founded by the Anesthesia Departments of the Harvard Medical School affiliated hospitals: Beth Israel Deaconess Medical Center, Brigham and Women's Hospital, Children's Hospital, and Massachusetts General Hospital. CMS is dedicated to provide medical education using dynamic teaching tools. CMS has been operational since 1993 and has performed numerous training programs for over 1000 clinicians. Course topics have included Crisis Management, Performance Enhancement, and Teamwork. CMS offers educational programs for Anesthesiologists, Emergency Medicine Physicians, Intensivists, Internal Medicine Physicians, Radiologists, Surgeons, and others. Courses for Nurses, Paramedics, Respiratory Therapists, and other clinical personnel are also provided. CMS has special programs for Medical Device and Pharmaceutical Company personnel. All programs make extensive use of full-scale simulation systems, computer simulations, and part-task trainers. We invite you to participate in one of our unique courses. Continuing Medical Education credits are available through the Harvard Medical School Office of Continuing Education.

## Center for Simulation Technology & Academic Research

Evanston Northwestern Healthcare's Center for Simulation Technology Academics and Research (CSTAR). CSTAR uses simulators which are particularly effective for developing skills in the rapid assessment and treatment of critical conditions, particularly those illnesses which are not seen every day in the ED, helping to reduce error and enhance the safety of our patients. Simulators are also effective for training police and paramedics in how to respond to potential bioterrorist attacks. The simulators have helped teach paramedics, police and firefighters how to respond safely prior to the arrival of a hazardous materials team.

## **Sonosite**

SonoSite, Inc. is the worldwide market and technology leader in high performance, hand-carried ultrasound. Through its expertise in ASIC design, SonoSite is able to offer imaging performance typically found in ultrasound systems weighing more than 300 pounds in a system architecture that is approximately the size and weight of a laptop computer and provides a significant price to performance advantage compared to conventional systems. This breakthrough is transforming and expanding the worldwide diagnostic ultrasound market by serving existing clinical markets more efficiently and creating new point-of-care applications where ultrasound was either too cumbersome or too expensive to be used before. With over 15,000 systems sold since 1999, SonoSite products are known for exceptional performance, ease of use and durability.

## **SunMedical/WISER**

The Peter M. Winter Institute for Simulation Education and Research (WISER), allied with the Safar Center for Resuscitation and Research at the University of Pittsburgh, is dedicated to medical education and educational research. The Institute features advanced instructional technology to develop innovative medical education programs that are ultimately targeted towards improving the public medical welfare and safety. Its educational research missions include the application of university standards of excellence and professionalism to study the efficacy of educational training programs and their impact on learning and on clinical care. The Institute employs and develops advanced instructional technology - including interactive human simulation, computer-based simulation technology, Internet, and video learning systems - to enhance medical education. As one of its fundamental goals, the Institute facilitates the development of academic educational researchers.

These companies support STA and have representatives attending but are not 2005 conference exhibitors.

## **Criticare Systems, Inc.**

Criticare offers its POET IQ 8500 series anesthetic monitors that identify SEV, HAL, ENF, DES, ISO and include O<sub>2</sub>, CO<sub>2</sub> and N<sub>2</sub>O detection. Criticare offers a full compliment of multi-parameter patient monitors with configurable NIBP, IBP, SpO<sub>2</sub>, CO<sub>2</sub>, O<sub>2</sub>, ECG and temperature. CSI monitors deliver powerful performance at affordable prices.

## **GASNet**

GASNet provides high level resources for academic and clinically based health care providers, teachers and students, researchers and members of industry. To ensure accuracy and objectivity, the scholarly information contained on GASNet is created by invited experts, rigorously screened and edited. Responding to clinicians' demand for immediate access to clinical information in the workplace GASNet develops GASNet Guidebooks, electronic books full of hard to remember facts, lists and other data for use at Point of Care. GASNet Guidebooks are available on the Web and are downloadable to handheld devices.

## **Philips Medical**

Philips offers a robust portfolio of medical systems. The goal of each product is clear, faster and more accurate diagnosis and treatment. Our product line includes best-in-class technologies in X-ray, ultrasound, magnetic resonance, computed tomography, nuclear medicine, PET, radiation oncology systems, patient monitoring, information management and resuscitation products. We also offer a wide range of services. Including but not limited to training and education, business consultancy, financial services and e-care business services.

This information was provided by the exhibitor or taken from their website and received by December 30, 2004.

# 2005 STA and IMMS Abstracts

## by Presenting Author Name

IMMS	<b>Aitchison</b> Pamela Evanston Northwestern Med Center	<i>Physiologic Response to the Critically Ill Simulated Patient</i>
IMMS	<b>Alinier</b> Guillaume Univ of Hertfordshire	<i>A Touch of Added Realism: Preparation of Your Patient Simulator for CVP Monitoring</i>
IMMS	<b>Alinier</b> Guillaume Univ of Hertfordshire	<i>Development of an Organizational Model for Critical Care Interprofessional Simulation Training</i>
STA	<b>Ansermino</b> Mark BC Children's Hospital	<i>An Adaptive Change Point Detection Algorithm for Physiological Monitoring</i>
IMMS	<b>Avery</b> James Queens Medical Centre	<i>Acute Medicine Unit Senior Nurse Development Day: Combining dynamic advanced patient simulation scenarios and static clinical knowledge and skill-based exercises to meet training needs for senior staff</i>
IMMS	<b>Baxendale</b> Bryn Queens Medical Centre	<i>Evaluating the Use of Advanced Patient Simulation in Training for Final Year UK Medical Students in the Recognition of the Acutely Ill Patient, Immediate Management Strategies and Resuscitation Skills</i>
IMMS	<b>Becker</b> Les R. Pacfic Institute for Research & Evaluation	<i>Challenges to Fidelity in Prehospital Care Patient Safety Research &amp; Training</i>
IMMS	<b>Berkenstadt</b> Haim Sheba Medical Center	<i>Feasibility of Sharing Simulation-Based Evaluation Scenarios in Anesthesiology</i>
IMMS	<b>Blum</b> Richard Children's Hospital/ Anesthesia	<i>Instructor Qualification Guidelines for Crisis Resource Management</i>
STA	<b>Bowering</b> John St. Paul's Hospital	<i>A Continuous Noninvasive Blood Pressure Monitoring Apparatus with Automatic Recalibration</i>
IMMS	<b>Brown</b> Darral Univ of Florida	<i>Use of a Simulation-Based Training Program at NF/SG VA Health System to Train Residents and Nurse Practitioners in Lower Gastrointestinal Tract Endoscopy</i>
IMMS	<b>Brown</b> Russell	<i>Simulation in the Education of Anesthesiologists in Canada</i>
STA	<b>Chang</b> Janelle Dartmouth College	<i>Investigating Respiratory Variation in the Plethysmograph to Identify Obstructive Sleep Apnea</i>
IMMS	<b>Cimino</b> Linda St. University of NY at Stony Brook	<i>Value of Medical Simulation for Residents with Tactual/Kinesthetic Learning Styles (and specialties?)</i>
IMMS	<b>DeSousa</b> Susan Sunnybrook & Womens	<i>Procedural Skills Development Using Simulated Models</i>
IMMS	<b>Dongilli</b> Thomas Wiser Institute	<i>Using Simulation Based Learning Systems to Train a Large Urban EMS Service in Difficult Airway Management</i>
IMMS	<b>Dongilli</b> Thomas Wiser Institute	<i>The BIG Shock - AED Trials for Non-Experienced Responders</i>
IMMS	<b>Eppich</b> Walter Yale University Hospital	<i>Integration of Human Patient Simulation into a Pediatric Advanced Life Support Course for Community Practitioners</i>
IMMS	<b>Flin</b> Rhona Univ of Aberdeen	<i>A Behavioural Marker System to Rate Surgeons' Non-technical Skills</i>

STA	<b>Fuehrlein Brian</b> University of Florida	<i>Pulse Oximetry Data Acquisition Viewer (PODAV) - New Plethysmograph Processing Software</i>
IMMS	<b>Gelbvaks Sergio</b> Berkley Training Ctr in Brazil	<i>Virtual Hospital &amp; Simulators: A New Trend in Health Education in Brazil</i>
STA	<b>Ghelber Oscar</b> UT Health Science Center	<i>Use of Compuflow for the Identification of the Epidural Space - a Preliminary Study</i>
IMMS	<b>Gillespie Sarah</b>	<i>A Novel (?) Five Day Human Patient Simulation Curriculum for Anesthesiology Residents</i>
IMMS	<b>Gillespie Sarah</b>	<i>An Introduction to Clinical Medicine for Biomedical Engineering Students Through Simulation</i>
IMMS	<b>Goodrow Mike</b> University of Louisville	<i>Using Patient Simulators to Reinforce Emergency Response Training for Non-Clinical Personnel</i>
IMMS	<b>Gordon James</b> Massachusetts General Hospital	<i>The Institute for Medical Simulation: A New Resource for Medical Educators Worldwide</i>
IMMS	<b>Gould Robert</b> Northwestern University Med. School	<i>Simulating an Airway Firew with METI HPS-101 Mannequin</i>
IMMS	<b>Grapengeter Martin</b>	<i>Does Communication Training in Anesthesiology Improve Patient Safety?</i>
STA	<b>Graybeal John</b> Masimo	<i>Perfusion Index Reflects Physiologic Changes in Blood Flow Resulting from Cold Exposure</i>
STA	<b>Greenberg Jason</b> University of Chicago Hospitals	<i>Using the Computer to Order Laboratory Tests for a Research Protocol in the Preoperative Clinic</i>
IMMS	<b>Harter Phillip</b> Stanford University	<i>Comparison of Student Perceptions of Web-based Virtual Reality and HPS Simulation Training in Trauma Management</i>
IMMS	<b>Heinrichs Wolfgang</b> Simulation Center Mainz	<i>A Wireless Syringe Detection Device. More Fidelity and Realistic Drug Application in METI's Simulators</i>
STA	<b>Hodgson David</b> Kansas State Univ.	<i>Inhalation Anesthesia Induction in Caged, Wild Animals Using a Novel Anesthetic Delivery Device</i>
IMMS	<b>Hunt Elizabeth</b> Johns Hopkins	<i>Simulation of Pediatric Trauma Stabilization in NC Emergency Departments: Identification of Targets for Performance Improvement</i>
IMMS	<b>Johnson Ken</b> University of Utah	<i>Introduction to Part Task and Variable Priority Training in First Year Anesthesia Resident Education: A Combined Didactic and Simulation Based Approach to Improve Management of Adverse Respiratory Events</i>
IMMS	<b>Johnson Ken</b> University of Utah	<i>Exploration of Partial Task and Variable Priority Training for Anesthesia Residents to Improve Management of Adverse Respiratory Events: Preliminary Results</i>
STA	<b>Jurman Ariel</b> NYU Medical Center	<i>BIS Variability as a Measure of Depth of Analgesia</i>
IMMS	<b>Kaminoh Yoshiroh</b> Hyogo College of Medicine	<i>Experience with Anesthesia Case Management of Simulated Patients by HPS Promotes the Knowledge Acquisition about Anesthesia by Medical Students</i>
IMMS	<b>Kozmenko Valeriy</b> LSU Health Science	<i>Teaching Clinical Skills for Undergraduate Medical Students Through Inquiry with the Use of High Fidelity Human Patient Simulator</i>
IMMS	<b>LeBlanc Vicki</b> Univ of Toronto	<i>Comparison of Simulation-Based Written and Skills Examinations in Predicting Field Performance by Paramedics</i>



IMMS	<b>Lighthall</b> Geoffrey Stanford University	<i>The Use of Simulation to Train Medical Residents to be Code Team Leaders.</i>
IMMS	<b>Lim</b> Michael John Radcliffe Hospital	<i>Building your own Oxford Simulation Apparatus for Flexible Endoscopy (OxSAFE)</i>
IMMS	<b>Lighthall</b> Geoff Stanford	<i>Development of a Scoring System to Evaluate the Management of Septic Shock</i>
STA	<b>Lim</b> Michael John Radcliffe Hospital	<i>An XML-based Training Log (XTraLog): A Clinical Application of XML Technologies</i>
IMMS	<b>Lim</b> Michael John Radcliffe Hospital	<i>The Oxford Simulation Apparatus for Flexible Endoscopy (OxSAFE)</i>
STA	<b>Lowe</b> Andrew	<i>Arterial Pulse Wave Reflection Assessed Using Suprasystolic Brachial Artery Recordings</i>
IMMS	<b>Lutz</b> John Univ of Pittsburgh Wiser	<i>The Use of Simulation Information Management System (SIMS) for Data Mining of Simulation Sessions</i>
IMMS	<b>Mahoney</b> John University of Pittsburgh School of Medicine	<i>Integration of Human Patient Simulation into a Comprehensive Standardized Patient OSCE</i>
IMMS	<b>Manser</b> Tanja VA Palo Alto	<i>An Observation Method to Assess Coordination Processes in Anesthesia</i>
IMMS	<b>Marks</b> Roger Univ of Miami/Anesthesia	<i>Team Training for Medical Students - An Early Exposure to Crisis Resource Management</i>
STA	<b>McNeer</b> Richard University of Miami	<i>Encoding Urgency into Auditory Displays to Improve Patient Monitoring</i>
IMMS	<b>Meurling</b> Lisbet Karolinska University Hospital	<i>Leadership Behavior, but Not Attitude, Changes in Response to Short Term Team Training.</i>
IMMS	<b>Meyer</b> Elaine Children's Hospital & Harvard Medical School	<i>What Components of an End-of-Life Communication Simulation Program are Most Helpful to Trainees?</i>
IMMS	<b>Meyer</b> Elaine Children's Hospital & Harvard Medical School	<i>Lessons Learned from an End-of-Life Communication Simulation Model</i>
IMMS	<b>Miyagawa</b> Yasuko	<i>The Utilization of the Anesthesia Simulator Room at Hyogo College of Medicine after Three Years, from April 2001-March 2004.</i>
STA	<b>Moitra</b> Vivek University of Chicago Hospitals	<i>The Use of Real Time Automated Reminder System for Patient Recruitment in the Preoperative Clinic</i>
IMMS	<b>Morgan</b> Pamela Sunnybrook & Womens	<i>High Fidelity Simulation: Translating Theory into Practice in Undergraduate Medical Education</i>
STA	<b>Murphy</b> Robert Manukau Institute of Technology	<i>50ml Syringe Pumps - Are they Suitable for "High Risk" Infusions?</i>
STA	<b>Murray</b> Bosseau The Pennsylvania State University H 187	<i>Target Guided Infusion (TGI): Using Technology to Improve Understanding of Pharmacokinetic and Pharmacodynamic Principles</i>
STA	<b>Murray</b> Bosseau The Pennsylvania State University H 187	<i>Using Technology to Enhance the Safety of Technology: Another Look at GasMan</i>
IMMS	<b>Musson</b> Dave Univ of TX at Austin	<i>Personality and Attitudinal Influences on Team-Based Behavior in Medical Work Groups</i>
IMMS	<b>Naik</b> Viren	<i>Non-Technical Skills in Anesthesia Crisis Management with Repeated</i>

	St./ Michael's Hospital U of Toronto	<i>Exposure to Simulation Based Education</i>
IMMS	<b>Nakagawa Masashi</b>	<i>Difficult Airway Management (DAM) in Japan</i>
STA	<b>Nevo Igal</b> Center for Patient Safety UM	<i>Patient Safety Initiative - Information Technology Solutions to Improve Patient Safety in the State of Florida</i>
STA	<b>Ng Jessie</b> University of BC	<i>Evaluation of a Vibro-Tactile Display Prototype for Physiological Monitoring</i>
IMMS	<b>Nomura Takeshi</b> Shimane Univ School of Medicine	<i>Is ACLS Knowledge Valuable for Anaphylactic Shock Treatment? A simulation Study in Medical Students</i>
STA	<b>Orr Joseph</b> University of Utah	<i>Use of a Computer Model of Volatile Anesthetic to Estimate Emergence Time, With and Without CO2 Rebreathing</i>
STA	<b>Orr Joseph</b> University of Utah	<i>Evaluation of a Device to Speed Emergence from Volatile Anesthetic Using a Computer Model</i>
IMMS	<b>Owen Harry</b> Flinders University Medical Centre	<i>A Cricoid Pressure Trainer Designed to Improve Airway Management</i>
IMMS	<b>Pardo Manuel</b> UCSF	<i>Computerized Patient Simulation in the Preclinical Curriculum: Student Perceptions After Three Years</i>
STA	<b>Patel Biraj</b> NY University School of Medicine	<i>Ultrasound Guided Mid-Forearm Approach as a Rescue Technique for Failed Radial Artery Cannulation</i>
IMMS	<b>Pawlowski John</b> Beth Israel Deaconess	<i>Pilot Study: Evaluation of Whole-Body Simulation Used to Teach Cultural Competency to Medical Students</i>
IMMS	<b>Pawlowski John</b> Beth Israel Deaconess	<i>Pilot Study: Evaluation of Learning/teaching Effectiveness Using Multiple Exposures to Simulated Cardiovascular Clinical Scenarios</i>
IMMS	<b>Philip James H.</b> Brigham & Women's Hospital	<i>Gas Man Demonstrates Apnea Greatly Prolongs Time Available for Intubation During VIMA with Sevoflurane</i>
IMMS	<b>Phrampus Paul</b> Univ of Pittsburgh	<i>Death During Simulation Training: Feedback from Trainees</i>
IMMS	<b>Pozner Charles</b> Brigham & Women's Hospital	<i>Simulation as an Integral Component of an Emergency Medicine Residency at Harvard</i>
IMMS	<b>Raemer Daniel</b> Center for Medical Simulation	<i>Simulation-Based Crisis Training for Pain Management Specialists</i>
STA	<b>Rafferty Terence</b> Yale University	<i>Proposal for a Unique and Universally Applicable Wireless Interface System for Patient Monitoring During Transport</i>
STA	<b>Ranganathan Pavithra</b> NYU Medical Center	<i>Electrocardiogram is an Inaccurate Indicator of Cardiac Function</i>
STA	<b>Redford Daniel</b> University of Arizona	<i>Evaluation of the Tongue and Hard Palate as Alternative Sites for the Reflectance Pulse Oximetry Monitoring in Difficult to Monitor Surgical Patients</i>
STA	<b>Rehman Mohamed</b> St. Christ. Hospital for Children	<i>Wireless Local Area Network (WLAN) for Anesthesia Record Keeping. Can You Depend on Them for your Data?</i>
IMMS	<b>Rockstraw Leland</b> Drexell University CNHP	<i>The Psycho/Social Correlates of Using Simulated Clinical Practicum with Students Enrolled in a Baccalaureate Nursing Program</i>
IMMS	<b>Saied Nahel</b>	<i>Human Patient Simulation via Internet Based Video Teleconferencing</i>
IMMS	<b>Savoldelli Georges</b> Wilson Center for Research in Education	<i>Activities, Perceptions and Perceived Barriers Vary with the Level of Training</i>

IMMS	<b>Savoldelli Georges</b> Wilson Center for Research in Education	<i>The Evaluation of Patient Simulator Performance as an Adjunct to the Oral Examination for Senior Anesthesia Residents</i>
IMMS	<b>Schaefer John</b> Anes/Wiser Institute	<i>Functional Validity of Airway Techniques in Whole Task Human Simulation using Laerdal SimMan</i>
IMMS	<b>Schumacher Lori</b> Medical College of Georgia	<i>The Impact of Utilizing High-Fidelity Computer Simulation on Critical Thinking Abilities &amp; Learning Outcomes in Undergraduate Nursing Students</i>
IMMS	<b>Seropian Michael</b> Oregon Health Sciences	<i>Statewide Simulation Deployment in Oregon - It can Be Done</i>
IMMS	<b>Shapiro Marc</b> Brown Medical School	<i>Simulation Training in Emergency Preparedness (STEP): A Statewide Weapons of Mass Destruction (WMF) Training for Hospital Personnel</i>
STA	<b>Shelley Kirk</b> Yale University	<i>Time Domain Analysis of the Photoelectric Plethysmographic Waveform</i>
IMMS	<b>Siddall Viva</b> Northwestern University	<i>A Prospective Randomized Control Trial Focused on Simulated ACLS Support Training for Internal Medicine Residents</i>
IMMS	<b>Simon Robert</b> Center for Medical Simulation	<i>Challenging Superiors in the Healthcare Environment: The Two-Challenge Rule</i>
IMMS	<b>Singh Shashank</b> Pen State Hershey	<i>Trauma and Awareness</i>
IMMS	<b>Stanley Liana</b> Children's Hospital Boston	<i>Using Simulation Technology to Produce an Educational Video: Excellence in End-of-Life Care in the Pediatric Intensive Care Unit.</i>
IMMS	<b>Sudikoff Stephanie</b> Brown School of Medicine	<i>High Fidelity Medical Simulation as an Assessment Tool for Pediatric Resident Airway Management Skills</i>
IMMS	<b>Szarek John</b> Ross University School of Medicine	<i>Problem-based Learning Using a Human Patient Simulator and its Relation to One Model of Physician Learning</i>
IMMS	<b>Taekman Jeffrey</b> Duke University Medical Center	<i>Management Interface 0 Simulation: A Web-Based Calendar and Resource Reporting System for Simulation Centers</i>
IMMS	<b>Tarshis Jordan</b> Sunnybrook & Womens College HSC	<i>Creation, Implementation and Evaluation of a Nationwide Simulator Based CME Program for Family Practice Anesthetists</i>
STA	<b>Tejman-Yarben Shai</b> Sovoka Medical Center	<i>The Acoustic Sensor for Monitoring Ventilation of Separate Lungs</i>
STA	<b>Tewari Sanjay</b> NYU Medical Center	<i>Use of PDAs in the Storage and Retrieval of Anesthesia Pre-Operative Assessments</i>
STA	<b>Trager Guillaume</b> Universite de Montreal	<i>Development of a New Neuromuscular Monitoring System Using Phonomyography</i>
STA	<b>Trager Guillaume</b> Universite de Montreal	<i>The Staircase Phenomenon Revisited: Influence of Muscle Site and Monitoring Method</i>
IMMS	<b>Von Wyl Thomas</b> University Hospital	<i>Team Performance and Interrater Reliability in Simulated Emergency Situations</i>
IMMS	<b>Vozenilek John</b> Evanston Northwestern Healthcare	<i>Inter-rater Reliability Using an Automated Response System for Scoring Simulation Sessions</i>
IMMS	<b>Wade Lenny</b> Northwestern University	<i>Simulating One-Lung Ventilation: Making a Double Lumen Tube Work with the METI HPS 010 Adult Mannequin</i>

IMMS	<b>Wallin</b> Carl-Johan Huddinge Univ. Hospital	<i>Assessment of Team Training Using Engagement Modes and Self Efficacy</i>
STA	<b>Wallroth</b> Carl Drager	<i>Evaluating the Performance of Closed Loop Controllers in Anesthesia</i>
IMMS	<b>Walzer</b> Toni Center for Med Simulation	<i>Human Patient Simulation of Normal &amp; Abnormal Vaginal Birth Pilot Program for 3rd Year Harvard Medical Students</i>
IMMS	<b>Wang</b> Ernest Evanston Hospital	<i>Addressing the Systems-Based Practice Core Competency: A Simulation-Based Curriculum</i>
IMMS	<b>Weinstock</b> Peter Boston Childrens Hospital	<i>Integration of High-Fidelity Patient Simulation into Traditional Pediatric Critical Care Curriculum: Work in Progress</i>
STA	<b>Wendelken</b> Suzanne Dartmouth College	<i>Monitoring Respiration Rate in PACU Patients Using the Plethysmogram from a Pulse Oximeter</i>
IMMS	<b>Yule</b> Steven University of Aberdeen	<i>A Behavioural Marker System to Rate Surgeons' Non-technical Skills</i>
IMMS	<b>Zonfrillo</b> Mark Yale University	<i>Quantifying the Pediatric Simulation Literature: A Review of Outcomes-Based Research</i>

# STA 2005:

## Hot Tech for Anesthesia:

### Making Capital Equipment Decisions

January 13-15, 2005  
Radisson Resort, Miami FL

#### Wednesday, January 12, 2005

10:00 – 3:00 Meeting of the STA Board of Directors

2:00 – 4:00 Registration – continues daily 7 am – 4 pm

*Location*  
*Soprano*  
*Overture Foyer*

#### Thursday, January 13, 2005

7:00 – 8:00 Continental Breakfast

8:00 Welcome Remarks: Jeff Feldman, MD, President STA & George Blike, MD, Chair

8:15 – 9:30 Keynote Debate: The Promise of New Anesthesia Technologies...Techno-fantasy vs. Tangible Improvements

Richard I Cook, MD PhD, Cognitive Technologies Laboratory, University of Chicago

9:30 – 10:00 Break

Wireless Networking Committee: Mohamed Rehman, MD

10:00 – 12:00 Hot Tech Topic #1 – Portable Ultrasound Technologies

Panelists: Brian Sites, MD, Director of Regional Anesthesia, Dartmouth Medical Center,  
Brian Spence, MD, Assistant Prof. Of Anesthesiology, Dartmouth Medical Center

- Technical aspects of portable ultrasound
- Best indications, applications...contraindications, pitfalls
- Lessons learned by users of portable ultrasound
- Hands-on use of technology at workstations

STA Annual Awards and Business Luncheon

12:30 – 2:00 Presentation of the J. S. Gravenstein Technology Award

Local activities

2:00 – 5:00 Research Session I – Oral Presentations

5:00 – 5:30 Research Session II – Professor Rounds Posterside

5:30 – 6:30 Plug and Play Work Group Session

5:30 – 7:00 Joint Meeting Welcome Reception in Technology Showcase area

*Symphony I*

*Symphony II*  
*Concerto A-C*  
*Market*  
*Concerto A-C*

*Overture Foyer*

*Symphony II*

*Metronome*  
*Symphony II*

# Friday, January 14, 2005

## Continental Breakfast in Technology Showcase Area

**Joint Session Opening:** Past, Present and Future; the unique relationships between STA &

IMMS

Jeff Feldman, MD, President STA

Dan Raemer, PhD, President SMS

## **Joint Session with International Meeting on Medical Simulation**

- **SocioTechnical Simulation and Care Process Transformation:** *Paul Uhlig, MD, MPA,*

*Massachusetts General Hospital, Boston, MA*

## **Technology Showcase; Posters and Demonstrations**

**Tech Education Committee:** John Doyle, MD

## **Hot Tech Topic #2 – Non-OR Anesthesia (NORA) Technologies**

**Moderators:** Charlotte Bell, MD, Chief of Pediatric Anesthesiology NYU, NY; Patricia Sequeira, MD, NYU, NY

Panelists Jay Iaconetti, MD, Director of NORA at Fairfax Hospital, VA, and James Koinsburg, MD, NORA at Fairfax Hospital, VA, and Beverly K. Philip, MD Director of NORA at Brigham Women's Hospital, MA

- Context of care-the environment, hazards and unique challenges
- Portability- monitors, drug delivery systems, transport equipment, drug security
- Footprints - setting up NORA suites, information management, electronic records
- Operations- scheduling, credentialing, billing, purchases both for safety and economics

## **On-Line Tech Review Committee: Leslie Jameson, MD**

## **Lunch on your own followed by local activities**

- Indicate (on your registration form) an interest in playing golf near-by
- Check out the Art Deco world of Miami
- And then there is always South Beach

## **Show and Share – Anesthesia technology applications for handhelds, laptops, office or home \*\***

**Session Chair:** Peter Fine, MD, UMDNJ

- Demonstrations of software applications
- Sharing (using portable USB drives, CD's, Flash Memory, etc.)
- Networking to problem solve

## **The Great Gathering**

**Jimmy Buffett's Margaritaville Buffet and Great Social Gathering con't**

7:00 – 7:30

7:30 – 11:00

*Poolside*

*Symphony I & II*

*Concerto*

*Market*

*Symphony II*

*Market*

*Symphony II*

# Saturday, January 15, 2005

7:00 – 8:00

Continental Breakfast in Technology Showcase Area

7:30 – 8:00

STA Corporate Members' & Exhibitors' Presentations \*\*\*

8:15 – 9:15

Hot Technology Review 2005:

Speaker: George Blike, MD, Director of Dartmouth Medical Interface Lab., DHMC

- A comprehensive review of current and emerging technologies relevant to state-of-the-art anesthesia practice.
- Review will cover all aspects of peri-operative process from preop assessment to post-operative pain management.

9:15 – 9:30

Technology Showcase; Poster and Demonstrations

9:45 – 10:45

Hot IT Review 2005:

Speaker: Michael O'Reilly MD, University of Michigan

- A comprehensive review of current and emerging information technologies relevant to state-of-the-art anesthesia practice.
- Review will cover all aspects of peri-operative process from preop assessment to post-operative pain management.

10:45 – 11:00

Technology Showcase; Poster and Demonstrations

11:00 – 12:00

Genomics, a Critical Anesthesia Technology in the Future: Brian Donahue, MD, Vanderbilt University, Nashville, TN

*Concerto A-C  
Symphony II  
Symphony II*

*Concerto A-C  
Symphony II*

*Concerto A-C  
Symphony II*

## Poster Timetable

Posters Put up

Wednesday, January 12      2:00 – 4:00 pm  
or Thursday, January 13      before 7:00 am

Authors will be in attendance with their posters during the following times:

Thursday, January 13

9:30 – 10:00 am

5:30 – 6:30 pm

Friday, January 14

7:00 – 8:00 am

9:30 – 10:00 am

Posters Taken down

Friday, January 14

10:00 – 10:30 am

# STA Faculty & Presentors

Charlotte Bell MD  
New York University  
New York, NY  
*bell@gasnet.org*

Richard Cook MD  
University of Chicago  
Chicago IL  
*ri-cook@chicago.edu*

Brian Donahue MD  
Vanderbilt University  
Nashville TN

Peter Fine MD  
UMDNJ Med. School  
Newark NJ  
*finepl@umdnj.edu*

Jay Iaconetti MD  
Fairfax Hospital  
Fairfax VA

Jim Koinsburg MD  
Fairfax Hospital  
Fairfax, VA

Michael O'Reilly MD, MS  
U of Michigan School of Medicine  
Ann Arbor MI  
*oreillym@umich.edu*

Beverly K. Philip MD  
Birgham Women's Hospital  
Boston MA

Daniel Raemer PhD  
Center for Medical Simulation  
Cambridge MA  
*draemer@partners.org*

Pat Sequeria MD  
New York University  
New York, NY

Brian Sites MD  
Dartmouth Medical Center  
Hanover, NH

Brian Spence MD  
Dartmouth Medical Center  
Hanover, NH

All faculty have been requested to provide disclosure on any conflict of interest by indicating so at the beginning of their presentation. If you perceive any conflict of interest not properly disclosed, please make a comment on your evaluation form. Thank you.



## Keynote Faculty

### **Richard Cook**

Dr. Richard Cook is a physician, educator, and researcher at the University of Chicago. His current research interests include the study of human error, the role of technology in human expert performance, and patient safety. He worked in the computer industry in supercomputer system design and engineering applications. He received the MD degree from the University of Cincinnati in 1986. He was a researcher on expert human performance in Anesthesiology and Industrial and Systems Engineering at The Ohio State University. He is a faculty in the Department of Anesthesia and Intensive Care of the University of Chicago and Associate Director for the GAPS (Getting At Patient Safety) project sponsored by the Veterans Health Administration.

Dr. Cook has been involved with the National Patient Safety Foundation since its inception and sits on the Foundation's Board. He is internationally recognized as a leading expert on medical accidents, complex system failures, and human performance at the sharp end of these systems. He has investigated a variety of problems in such diverse areas as urban mass transportation, semiconductor manufacturing, and military software systems.

Dr. Cook's most often cited publications are "Gaps in the continuity of patient care and progress in patient safety", "Operating at the Sharp End: The complexity of human error", "Adapting to New Technology in the Operating Room", and the report "*A Tale of Two Stories: Contrasting Views of Patient Safety*"

### **Paul Uhlig**

Dr. Uhlig is a Cardiothoracic Surgeon and Associate Professor of Surgery at Massachusetts General Hospital. His professional interest concerns the relationships and patterns of interaction that surround the care process, and how these can be optimized to improve patient care. Dr. Uhlig and other members of the cardiac surgery team at Concord Hospital, Concord, New Hampshire, received the John M. Eisenberg Patient Safety Award from JCAHO and the National Quality Forum for their work developing a collaborative care model that includes patients and families in all aspects of care and decision making. Dr. Uhlig and his colleagues have spoken extensively about patient safety and the Collaborative Care Model throughout the country.

### **Brian Donahue**

Dr. Donahue is a Cardiac Anesthesiologist at Vanderbilt University and a Principle Investigator at one of only four "Functional Genomics" labs in the United States funded by the NIH. This Lab is focused on major scientific challenges facing anesthesiology which include identifying the means to prevent life-threatening and costly medical disabilities associated with the period surrounding surgery such as: stroke, heart attack, arrhythmia, chronic pain, and abnormal bleeding. Dr Donahue's functional genomics research translates the emerging discoveries in the human genome into solving the major healthcare problems that manifest in the perioperative period.

# 2005 STA Abstracts

Those marked "Demo" are located in the demonstration area of the poster room.

- 1     **Ansermino Mark**  
BC Children's Hospital  
anserminos@yahoo.ca  
*An Adaptive Change Point Detection Algorithm for Physiological Monitoring*
- 2     **Bowering John**  
St. Paul's Hospital  
jukbow@shaw.ca  
*A Continuous Noninvasive Blood Pressure Monitoring Apparatus with Automatic Recalibration*
- 3     **Chang Janelle**  
Dartmouth College  
janelle.chang@dartmouth.edu  
*Investigating Respiratory Variation in the Plethysmograph to Identify Obstructive Sleep Apnea*
- 4     **Fuehrlein Brian**  
University of Florida  
brianf@ufl.edu  
*Pulse Oximetry Data Acquisition Viewer (PODAV) - New Plethysmograph Processing Software*
- 5     **Graybeal John**  
Masimo  
jgraybea@masimo.com  
*Perfusion Index Reflects Physiologic Changes in Blood Flow Resulting from Cold Exposure*
- 6     **Greenberg Jason**  
University of Chicago Hospitals  
jasong@uchicago.edu  
*Using the Computer to Order Laboratory Tests for a Research Protocol in the Preoperative Clinic*
- 7     **Hodgson David**  
Kansas State Univ.  
hodgson@vet.k-state.edu  
*Inhalation Anesthesia Induction in Caged, Wild Animals Using a Novel Anesthetic Delivery Device*
- 8     **Jurman Ariel**  
NYU Medical Center  
jurmaa01@med.nyu.edu  
*BIS Variability as a Measure of Depth of Analgesia*
- 9     **Lim Michael**  
John Radcliffe Hospital  
michael.lim@nt1world.com  
*An XML-based Training Log (XTraLog): A Clinical Application of XML Technologies*
- 10    **Moitra Vivek**  
University of Chicago Hospitals  
vmoitr@dacc.uchicago.edu  
*The Use of Real Time Automated Reminder System for Patient Recruitment in the Preoperative Clinic*
- 11    **Murphy Robert**  
Manukau Institute of Technology  
romurphy@manukau.ac.nz  
*50ml Syringe Pumps - Are they Suitable for "High Risk" Infusions?*
- 12    **Murray W. Bosseau**  
Penn State College of Medicine  
wbmurray@psu.edu  
*Target Guided Infusion (TGI) Using Technology to Improve Understanding of Pharmacokinetic and Pharmacodynamic Principles*
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*Using Technology to Enhance the Safety of Technology: Another Look at GasMan*

- 14** **Nevo Igal**  
Center for Patient Safety UM  
[inevo@miami.med.edu](mailto:inevo@miami.med.edu)  
*Patient Safety Initiative - Information Technology Solutions to Improve Patient Safety in the State of Florida*
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University of Utah  
[joe.orr@hsc.utah.edu](mailto:joe.orr@hsc.utah.edu)  
*Use of a Computer Model of Volatile Anesthetic to Estimate Emergence Time, With and Without CO2 Rebreathing*
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NYU Medical Center  
[rangap01@med.nyu.edu](mailto:rangap01@med.nyu.edu)  
*Electrocardiogram is an Inaccurate Indicator of Cardiac Function*
- 18** **Rehman Mohamed**  
St. Christ. Hospital for Children  
[annette.silverman@tenethealth.org](mailto:annette.silverman@tenethealth.org)  
*Wireless Local Area Network (WLAN) for Anesthesia Record Keeping. Can You Depend on Them for your Data?*
- 19** **Shelley Kirk**  
Yale University  
[kirk.shelley@yale.edu](mailto:kirk.shelley@yale.edu)  
*Time Domain Analysis of the Photoelectric Plethysmographic Waveform*
- 20** **Wallroth Carl**  
Drager  
[beate.moeller@draeger.com](mailto:beate.moeller@draeger.com)  
*Evaluating the Performance of Closed Loop Controllers in Anesthesia*
- 21** **Ghelber Oscar**  
UT Health Science Center  
[oghelber@uth.tmc.edu](mailto:oghelber@uth.tmc.edu)  
Demo  
*Use of Compuflow for the Identification of the Epidural Space - a Preliminary Study*
- 22** **Lowe Andrew**  
[andrew.lowe@pulsecor.com](mailto:andrew.lowe@pulsecor.com)  
Demo  
*Arterial Pulse Wave Reflection Assessed Using Suprasystolic Brachial Artery Recordings*
- 23** **McNeer Richard**  
University of Miami  
[mcneer@miami.edu](mailto:mcneer@miami.edu)  
Demo  
*Encoding Urgency into Auditory Displays to Improve Patient Monitoring*
- 24** **Ng Jessie**  
University of BC  
[jessien@ece.ubc.ca](mailto:jessien@ece.ubc.ca)  
Demo  
*Evaluation of a Vibro-Tactile Display Prototype for Physiological Monitoring*
- 25** **Patel Biraj**  
NY University School of Medicine  
[navparkashsandh@hotmail.com](mailto:navparkashsandh@hotmail.com)  
Demo  
*Ultrasound Guided Mid-Forearm Approach as a Rescue Technique for Failed Radial Artery Cannulation*
- 26** **Rafferty Terence**  
Yale University  
[rafferty@aya.yale.edu](mailto:rafferty@aya.yale.edu)  
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*Proposal for a Unique and Universally Applicable Wireless Interface System for Patient Monitoring During Transport*

27

Demo

**Redford Daniel**  
University of Arizona  
rdaniel29@msn.com

*Evaluation of the Tongue and Hard Palate as Alternative Sites for the Reflectance Pulse Oximetry Monitoring in Difficult to Monitor Surgical Patients*

28

Demo

**Tejman-Yarben Shai**  
Sovoka Medical Center  
tegmnya@inter.net.il

*The Acoustic Sensor for Monitoring Ventilation of Separate Lungs*

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Demo

**Tewari Sanjay**  
NYU Medical Center  
jung.kim@med.nyu.edu

*Use of PDAs in the Storage and Retrieval of Anesthesia Pre-Operative Assessments*

30

Demo

**Trager Guillaume**  
Universite de Montreal  
gtrager@yahoo.com

*The Staircase Phenomenon Revisited: Influence of Muscle Site and Monitoring Method*

31

Demo

**Trager Guillaume**  
Universite de Montreal  
gtrager@yahoo.com

*Development of a New Neuromuscular Monitoring System Using Phonomyography*

32

Demo

**Wendelken Suzanne**  
Dartmouth College  
suzanne.wendelken@dartmouth.edu

*Monitoring Respiration Rate in PACU Patients Using the Plethysmogram from a Pulse Oximeter*

The abstract author(s) who have identified corporate/industry involvement regarding their research are listed below.

#	Company
2	VSM MedTech Ltd.
4	Beta Biomed Services Inc.
5	Masimo
9	British Journal of Anesthetics & Royal College of Anesthetics
15	Axon Medical
16	Axon Medical
20	Draeger Medical AG & G
21	Milestone Scientific
22	Pulsecor Ltd.
26	Cardiopulmonary Corporation
27	Masimo

# An Adaptive Change Point Detection Algorithm for Physiological Monitoring

Guy Dumont\*, Ping Yang\*, Craig Ries<sup>§</sup>, Mark Ansermino<sup>§</sup>

Departments of \*Electrical & Computer Engineering and <sup>§</sup>Anesthesia, The University of British Columbia, Vancouver, Canada

Current clinical monitoring systems depend on crossing a maximum or minimum threshold for alerting the clinician to significant changes in the patient's condition. Thresholds are typically based on arbitrary determined limits. These systems lead to high false alarm rates and low utilization. Determining the change in a parameter over time offers the potential for improved clinical monitoring, reducing the clinician's cognitive workload. The historical features monitored for each parameter in individual subjects can be used to determine when that parameter has changed, with the most recent information having the most influence in detecting a change point.

We describe an adaptive change point detection algorithm for real time monitoring and report preliminary results. An adaptive Kalman filter computes estimates of the noise covariances of the dynamic linear model used to describe the monitored signal, as well as an estimate of the current slope and a denoised version of the signal. A CUSUM whose thresholds and target are adapted using these estimates, via an EWMA model, then detects the change points and provides a signal state descriptor of clinical relevance.

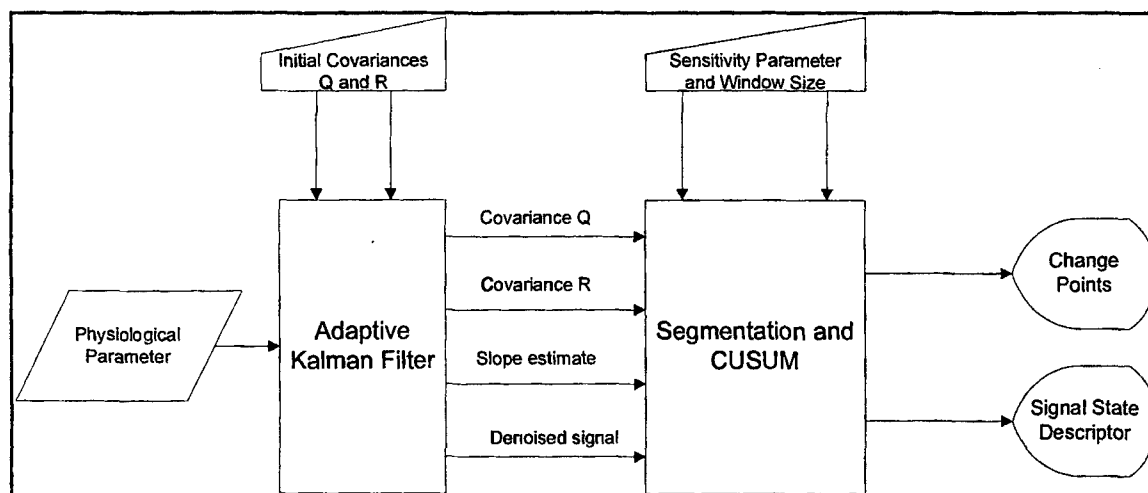


Figure 1. The proposed change-point detection algorithm

The algorithm was tested on heart rate series acquired on 20 anesthetized children undergoing various surgical procedures. It detected 38 (81%) of the change points deemed significant by clinicians performing careful post-hoc analysis versus about 36 (77%) detected by the clinicians during the surgical procedure. The false positive detection rate was similar to that of the clinician.

This adaptive change point detection algorithm is thus comparable to the clinician in real time.

## A Continuous Noninvasive Blood Pressure Monitoring Apparatus with Automatic Recalibration

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**Introduction:** This study replicates and expands on previous findings which indicated that a continuous noninvasive blood pressure (CNIBP) monitoring prototype, the Beat-to-Beat (VSM MedTech Ltd., Vancouver, Canada), was able to track blood pressure changes in patients in the cardiac surgery ICU (CSICU) [1]. An improved standalone CNIBP prototype was employed in the current study to measure and display systolic BP, diastolic BP and pulse waves continuously and non-invasively. This was achieved using the principle of pulse transit time with embedded real-time automatic recalibration algorithms. This current prototype uses two optical pulse detectors which are placed either on an earlobe, fingertip or toe. This is coupled with a commercially available NIBP oscillometric monitor, Dinamap Pro 400 (GE, Florida, USA) to provide reference readings for both initial calibration and automatic recalibration. We assessed the accuracy and tracking capability of this new prototype by comparing BP readings measured invasively via a radial arterial catheter (RAC) to those obtained by the Beat-to-Beat.

**Methods:** We studied 28 volunteer subjects (male 19, female 9) either undergoing cardiac surgery or postoperatively in the CSICU. Subjects had a mean  $\pm$  SD age of  $64 \pm 13$  years, weight of  $81 \pm 14$  kg, and height of  $168 \pm 9$  cm. Studies were performed during the cardiac surgical procedure (14 subjects) or commencing 20 to 60 minutes post-operatively (14 subjects). Study durations ranged from 75 to 390 minutes. The RAC and the NIBP cuff were placed on alternate sides of the subjects. Beat-to-Beat sensors were placed on the ear and finger or ear and toe. The RAC monitor displayed BP every 3 seconds and data acquisition software was used to record patient's physiological parameters via RS232/Ethernet data connection. The Beat-to-Beat prototype automatically updated BP readings approximately every heartbeat. BP readings obtained by the Beat-to-Beat were compared with those from the RAC.

**Results:** There were 28 subjects with a total of 272,445 measurements recorded by the CNIBP monitor. The mean  $\pm$  SD difference between the CNIBP and the RAC values for systolic BP was  $-9.85 \pm 13.18$  mmHg, and diastolic was BP  $0.13 \pm 7.05$  mmHg. Due to well established differences between direct and indirect BP measurements, a comparison was also made between the NIBP and RAC measurements to quantify the contribution of the NIBP to the results. 224 intermittent NIBP readings were collected in the study. The accuracy of the NIBP compared to the RAC was  $-11.32 \pm 11.37$  mmHg for systolic BP and  $0.61 \pm 8.74$  mmHg for diastolic BP. To allow the prototype to compensate for changes in arterial compliance and motion artifact, automatic recalibration (by NIBP) algorithms were used. The average recalibration interval was 20.2 minutes.

**Conclusions:** The latest Beat-to-Beat CNIBP prototype demonstrated excellent BP tracking capability compared with the direct measurements from the RAC. It provided accurate measurements comparable to that of intermittent NIBP monitoring in a patient population where there are rapid and significant changes in arterial compliance.

**Reference:** [1] Goldberg J, Lichtenstein S, Bowering J "A New Continuous Noninvasive Method to Monitor Blood Pressure," International Anesthesia Research Society 76th Clinical and Scientific Congress. San Diego, California, USA. March 16-20, 2002.

# Investigating respiratory variation in the plethysmograph to identify obstructive sleep apnea

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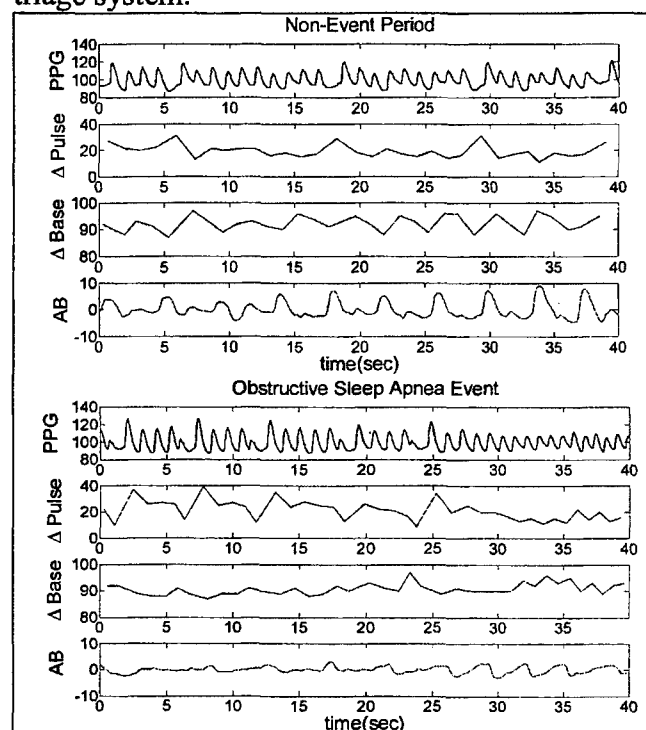
**Introduction:** Our team has been developing an automated remote triage system for emergency response incidents based on the START triage protocol<sup>1</sup>. In patients who are unable to walk and unresponsive, remote sensing of airway, breathing, and circulation status is required to execute the triage. The photoplethysmograph is a portable, inexpensive, and readily available sensor that has potential for this application. This study explores the features of the photoplethysmograph signal that are predictive of obstructive events.

**Method:** Patients were recruited by the Dartmouth Hitchcock Medical Center Sleep Disorders Laboratory. Polysomnograph (gold standard for diagnosing sleep apnea<sup>2</sup>) and photoplethysmograph recordings from a forehead pulse oximeter were made for each patient during the overnight sleep study. The photoplethysmograph signals corresponding to obstructive sleep apnea (OSA) and normal events were analyzed by investigating the average pulse height and respiratory waveform variation defined by pulse height variability, average change in baseline<sup>3</sup>, and average change in pulse peak over a respiratory cycle.

**Results:** Preliminary results from 3 patients indicate that there is an overall increase in pulse height when an OSA event occurs. Respiratory waveform variation was completely undetectable from changes in pulse peaks and also did not seem to be detectable from fluctuations in pulse height. The baseline of the plethysmograph was the only feature of the signal that indicated that respiratory variation might noticeably change for an OSA event. For instance, during 2 non-event periods and 3 OSA event periods within the same patient, the average pulse height increased from  $17.3 \pm 6.5$  for non-event periods to  $21.7 \pm 9.9$  for OSA events. The average change in pulse height (non-event:  $12.8 \pm 4.6$ ; OSA:  $15 \pm 7.7$ ) did not appear significantly different so respiratory waveform variation between OSA and normal events seems undetectable while the change in baseline from inspiration to expiration over a respiratory

cycle had the most noticeable variation for an OSA event (non-event:  $6.2 \pm 1.6$ ; OSA:  $3.6 \pm 1.9$ ).

**Discussion:** These preliminary results suggest that there are some features of the plethysmograph that may be extracted to identify OSA events. Additional study is needed to incorporate data from a larger set of patients. If successful, the algorithms used to analyze the plethysmograph in this study will be incorporated into the automated remote triage system.



Figures 1 and 2: Plots of a non-event and an OSA event for the same sample patient showing the plethysmograph (PPG), pulse heights ( $\Delta$  Pulse), baseline signal ( $\Delta$  Base), and abdominal effort (AB).

<sup>1</sup> Garner, A., et al., Comparative Analysis of Multiple Casualty Incident Triage Algorithms. *Annals of Emergency Medicine*. 38(5). 2001.

<sup>2</sup> Moyle, J. Pulse Oximetry. London BMJ Books. 2002.

<sup>3</sup> Hartert, T.V., et al., Use of Pulse Oximetry to Recognize Severity of Airflow Obstruction in Obstructive Airway Disease. *Chest*. 115(2). 1999.

Pulse Oximetry Data Acquisition Viewer (PODAV) – New Plethysmograph Processing  
Software

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Pulse oximetry, a standard of care since the 1980's, measures oxygen saturation and heart rate. While most recent research has focused on artifact rejection, our efforts have been directed at extracting additional information from the plethysmograph derived from the infrared (IR) signal. Specifically we have developed new software for separating the AC and DC components of the plethysmograph.

Our PODAV system processes raw streaming data from up to three Novamatrix Model 520A OXYPLETH monitors simultaneously, including the red and IR data and the LED power setting. The processed data represents the amount of light that hits the photodetector and is plotted as a plethysmograph. It is separated into a pulsatile arterialized graphic display (the AC component) and venous capacitance (DC offset) display. The algorithm separates these components by:

- 1) Detecting the peaks and troughs of the signal using probabilistic artifact rejection based on the average heart rate.
- 2) Finding the midpoints between the peaks and troughs
- 3) Extracting the “non-cardiac” component as the interpolated curve that connects these midpoints
- 4) Extracting the “cardiac” component as the raw signal minus the “non-cardiac” component

We believe that phasic changes in the DC component reflect changes in regional venous blood volume, information about respiratory rate, respiratory effects on the cardiac system, and possibly the degree of airway obstruction during sleep apnea. Additionally, the amplitude or integration of the area under the curve of the AC component may contain information about blood flowing in the region of the detector.



Title: Perfusion Index reflects physiologic changes in blood flow resulting from cold exposure.

Authors: Graybeal JM, Petterson MT, Novak J.

Affiliations: Masimo Corporation, Irvine Ca. USA

Perfusion Index (PI) is calculated as the AC amplitude (AC amp) divided by the DC amplitude (DC amp) measured as the relative transmission of the Infrared signal. We studied the effect of cold exposure on peripheral perfusion and the PI and its components, the AC amp and DC amp. Studies were conducted under IRB approval. After informed consent, 8 adult healthy volunteers were seated in a recumbent chair in a cold room (60°C) and attached to standard monitoring including ECG, EtCO<sub>2</sub>, and blood pressure. Masimo LNOP Adt sensors were attached to the 2nd digit of the right and left hands and then connected to Masimo SET Radical pulse oximeters. Repeated oxyhemoglobin desaturations were induced by controlling FiO<sub>2</sub> to the subject until SpO<sub>2</sub> values decreased below 90%. The right hand (CH) of each subject was exposed to the cold environment while the left hand (WH) was wrapped in a heating blanket in an effort to maintain body temperature, to cause a differential in perfusion to the 2 extremities. Delay in detection of desaturations (DDD) were calculated between the WH and the CH. PI, the AC amp and DC amp were calculated, for both the CH and WH. DDD, PI, the AC amp and DC amp were compared for the initial and final exposure using a paired t-test with  $p < 0.05$  considered significant. Two subjects failed to demonstrate a DDD after cold exposure and were eliminated from further analysis. The initial DDD between the WH and the CH was  $0.02 \pm 0.04$  minutes and after 40 minutes of exposure to cold environment was  $0.53 \pm 0.24$  minutes,  $p < 0.01$ . Table 1 presents the PI, AC amp and DC amp data for before and after 40 minutes of cold exposure. In this experiment, different perfusion to the two arms was evident by the DDD. The PI decreased in the CH significantly compared to the WH, after exposure. The DC amp (nonpulsatile component) demonstrated an increase in transmission; i.e. less light was absorbed due to less nonpulsatile components, which reflects vasoconstriction, after exposure to cold environment in the CH but not in the WH. The AC amp (pulsatile component) changed in both the CH and WH, although the WH did not reach statistical significance. Both the AC amp and the DC amp change in response to decreased peripheral perfusion. The Perfusion Index parameter, which is a combination of both the AC amp and the DC amp of the IR signal, correctly reflects changes in peripheral perfusion resulting from exposure to a cold environment.

	Table 1					
	Perfusion Index (%)		AC amplitude		DC amplitude	
	Cold Hand	Warm Hand	Cold Hand	Warm Hand	Cold Hand	Warm Hand
Before Exposure	3.9 ± 2.3	4.0 ± 2.03	0.0076 ± 0.0035	0.0060 ± 0.0031	0.210 ± 0.064	0.163 ± 0.049
After Exposure	0.54 ± 0.29 *	1.62 ± 2.08	0.0013 ± 0.0006 *	0.0021 ± 0.0015	0.258 ± 0.093 *	0.185 ± 0.058

\* =  $p < 0.05$  for before vs after

## Using the Computer To Order Laboratory Tests for a Research Protocol in the Preoperative Clinic

Jason T Greenberg BS, Vivek K. Moitra MD, Bobbie Jean Sweitzer, MD

### **Introduction**

The preoperative clinic is an ideal site for patient recruitment for clinical studies. Currently, the preoperative clinic uses a computerized data management system, which includes the patient's history and results of physical examination and laboratory tests. We describe our use of the existing computerized system to automatically trigger the ordering of essential laboratory studies for clinical trials, in this case a hemoglobin test (HbA1c).

### **Methods**

We attached an automated trigger for laboratory tests to the current data management system used in our preoperative clinic. Once a patient has consented to enrollment in a clinical study, the caregiver can click an enroll button which triggers a series of automated vents. For example, the "DM2 Enroll" button activates an alert on the patient record indicating enrollment in a diabetes study and automatically orders a HbA1c test. It also generates a day of surgery reminder on the pre-operative assessment to draw blood pre-, intra-, and post-operatively for glucose testing. In addition, because the results for a HbA1c laboratory test take 24 hours, a tracking form is generated for follow-up of outstanding laboratory values.

### **Results**

The introduction of the automated laboratory trigger improved many aspects of the data collection process. Before its implementation, tests were not ordered for several patients enrolled in the clinical trial. After implementation, 100% of HbA1c tests were ordered, preventing missing data points. On the day of surgery, anesthesia staff were always reminded to draw blood perioperatively for glucose testing.

### **Conclusions**

The use of an automated laboratory trigger system in the preoperative clinic can improve and facilitate the data collection process in clinical trials.

## Inhalation anesthesia induction in caged, wild animals using a novel anesthetic delivery device.

David S. Hodgson, DVM

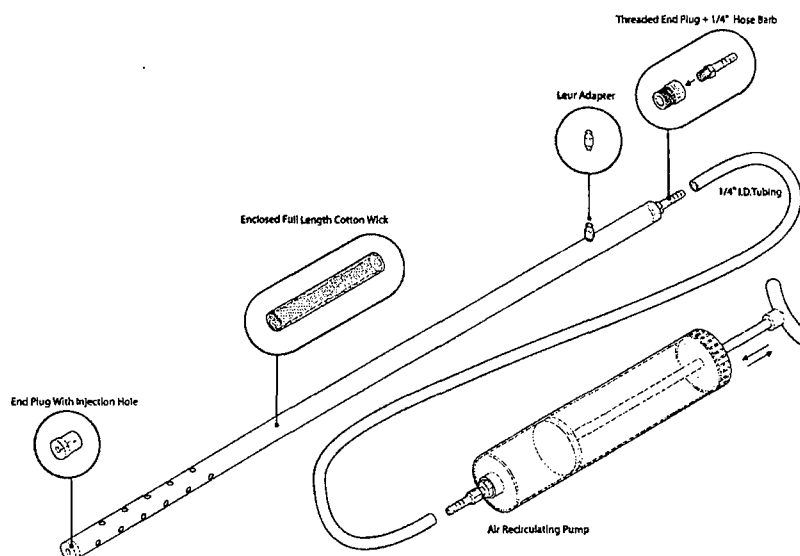
Department of Clinical Sciences, Kansas State University, Manhattan, KS 66506

**Introduction:** Exotic wild animals and fractious, aggressive pets are often presented in cages for treatment by veterinarians. Handling these animals in a manner that is both safe and humane may be impossible without anesthesia. Use of pole syringes or darts to deliver tranquilizers, sedatives or anesthetics may induce excessive fright and struggling leading to injury and distress. A novel anesthetic delivery device was developed and tested to administer inhalation anesthetics to caged animals in an economical fashion.

**Methods:** A novel anesthetic delivery device (vapor wand) was designed and consisted of a distally vented stainless steel tube enclosing a cotton wick. The vapor wand was connected via tubing to a 400 ml gas tight air recirculating pump. Various species of animals to be treated at the KSU Veterinary Medical Teaching Hospital were presented in cages. Cages were measured, volumes calculated and a maximum target isoflurane concentration selected. Using a formula or graph the appropriate volume of isoflurane liquid was aspirated into a plastic syringe and injected into the vapor wand wick. Cages were enclosed in a plastic trash bag. The bag open end was closed around a view port. The vented end of the vapor wand was inserted through the bag into the cage. The air pump was cycled to move cage gas in a to-and-fro fashion through the vapor wand. Animals were observed through the view port. When sufficiently anesthetized, the cage was opened, the animal removed and maintained with an anesthetic machine.

**Results:** Various species of primates, feline, and canine patients were induced with only isoflurane in air. Animals were not pre-medicated. Induction of anesthesia was smooth, quiet, rapid and stress free. Cage sizes ranged from 1,700 – 16,900 cubic inches. Induction times ranges from 2.6 – 7.5 minutes. Speed of induction was related to cage volume, faster inductions in small cages and more prolonged inductions in large cages. Inductions were more rapid with higher selected target concentrations of isoflurane.

**Discussion:** Isoflurane is inexpensive and well accepted by most animals. A maximum target concentration of 5% isoflurane was usually selected. This consistently produced smooth, stress free inductions. For sick or debilitated animals we sometimes select lesser target concentrations. When induction is complete, residual isoflurane remains in the vapor wand. After removing the animal from the cage, recovery is very rapid unless other methods of anesthetic maintenance are used. This vapor wand technique may be utilized in field situations, is economical and effective. Use of the device should be limited to properly trained professionals.



## **BIS Variability and Depth of Analgesia – A Pilot Study**

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Ariel Jurmann, MD

Alex Bekker, MD, PhD

Germaine Cuff, MS, RN

New York University Medical Center, Department of Anesthesia

**Background:** The BIS monitor has been used widely for several years as a monitor of depth of anesthesia. However, it has limitations. It is neither a predictor of patient movement nor a monitor of analgesia. A patient's BIS number during a stable anesthetic and during a time of unchanging surgical stimulation may fluctuate widely over short cycles of time and administration of an analgesic medication during this time may decrease the fluctuation of the BIS. This led us to the hypothesis that wide BIS variability may be an indicator of insufficient analgesia. We have performed a pilot study to investigate this phenomenon.

**Methods:** With IRB approval, fourteen patients undergoing spine surgery were enrolled in the study. Exclusion criteria for enrollment included preoperative use of any CNS-active medications, and surgeon's request for Motor Evoked Potential monitoring during surgery. Patients received midazolam premedication at the discretion of the providing anesthesiologist. All patients were monitored with ASA standard monitors and a BIS XP monitor (Aspect Medical Systems). Invasive hemodynamic monitoring was performed at the discretion of the providing anesthesiologist. General anesthesia was induced with propofol, the ultra-short acting opioid remifentanyl 0.5mcg/kg bolus followed by infusion at 0.25mcg/kg/min and vecuronium. All patients were maintained on a propofol infusion with a target BIS of 40, Oxygen 40-50% in air and intermittent vecuronium. Each patient was randomized either to have the remifentanyl infusion continue until 30 minutes after surgical incision and then be discontinued, or to have the remifentanyl discontinued prior to incision and then resumed 30 minutes after incision at the same dosage as noted above. BIS data were recorded at 5-second intervals throughout the anesthetic and a log was kept of the propofol and remifentanyl infusion rates and times at which either were changed. Additionally, in order to correct for differing degrees of painful surgical stimulation at differing portions of the case, a 5-second, 50mA tetanic stimulation was administered to the forearm at the ulnar nerve with the nerve stimulator at approximately 10-minute intervals throughout the anesthetic.

**Results:** Preliminary analysis suggests that many of our patients did show a higher degree of BIS variability during the analgesia-free portions of the anesthetic.

**Conclusions:** Wide short-term BIS variability may be an indicator of insufficient analgesia in patients under general anesthesia. A larger study is needed to elucidate this further and may eventually lead to expanded utility of the BIS monitor in patients under general anesthesia.

## An XML-based Training Log (XTraLog): A clinical application of XML technologies

Dr MW Lim, Dr SV Rutter

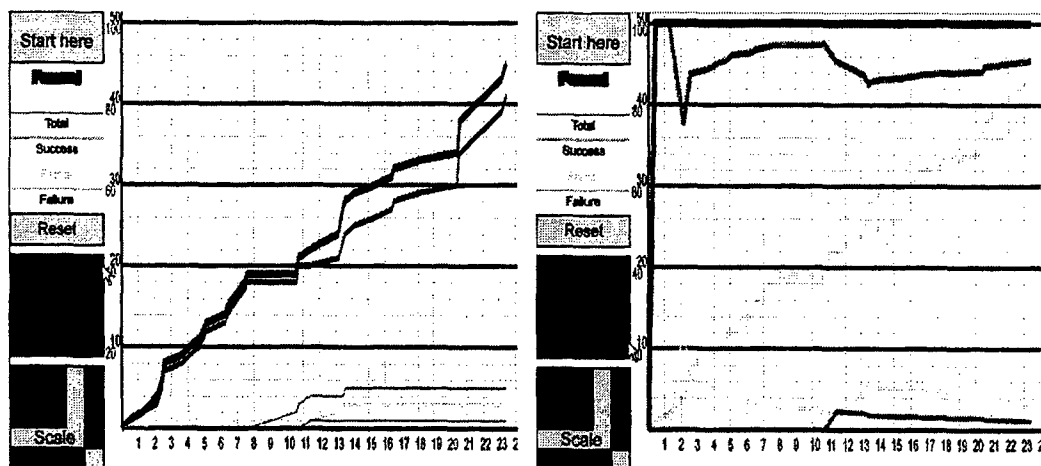
Nuffield Dept of Anaesthetics, University of Oxford

**Background:** Typically, pretty but static charts are used to show training progress. However, they are unable to convey details due to clutter. Interactive graphics offers an alternative by allowing users to select specific graphs to view. For reasons of cost, ease of customisation and base of support, we coded our interactive graphs using Scaleable Vector Graphics (SVG), an eXtensible Markup Language (XML)-based language.

**Methods:** The main user interface is a HyperText Markup Language (HTML) web page. On clicking the various links, a Java data entry form or Extensible Stylesheet Language (XSL) scripts are launched. These software entities allow user to input text in a user-friendly format, converts text into XML data and thence into web-based SVG and HTML table data. From the main user interface, the user can view the resulting graphs or tables.

The user chooses the information set he or she wishes to view by moving the mouse around the "Fade pad" (embedded graphic). The absolute numbers or percentages of unsupervised or supervised-unsupervised blocks can be quickly viewed and compared against one another. Where the numbers of the skill is low or the duration of monitoring prolonged, the graphs can be scaled vertically (only for absolute numbers) or horizontally respectively.

**Discussion:** XTraLog has several advantages. First, the ability to quickly switch between graphs on a consistent scale provides intuitive information ("eyeballing") that cannot be imparted by any other method. Second, the use of open standard, XML-based languages, keeps software costs down. Third, the use of familiar web-based form interfaces encourage clinician acceptance. Finally, the web-based nature of XML, allows the intriguing possibility of remote, frequent and informal monitoring of training progress, resulting in more responsive tailoring of training profile.



## The Use of a Real Time Automated Reminder System for Patient Recruitment in the Preoperative Clinic

Vivek K. Moitra MD, Jason T. Greenberg BS, Bobbie Jean Sweitzer, MD

### Introduction

A preoperative clinic also may be the site of patient enrollment for clinical studies. Currently our preoperative clinic uses a computerized data management system for patient information such as medications and medical history. We used the existing computerized system to include a real time automated reminder system to facilitate the identification and enrollment of diabetic patients into a clinical trial.

### Methods

We added an automated reminder to the current data management system. After a nurse enters the patient's medical history into the computer, the reminder system checks the data to see if the patient's history has certain characteristics -in this case, a diagnosis of diabetes mellitus type 2. If a match is found, a reminder in the form of a pop-up window is generated, asking the nurse or physician if they would like to enroll this patient. Once the patient has consented to enrollment, the practitioner may click a button "DM2 Enroll". This button triggers a pop-up window containing instructions for randomization of the patient for the study and a message in the patient's history alerting future caregivers that the patient is enrolled and needs certain laboratory tests drawn on the day of surgery, ie, fasting blood sugar. An enrolled patient's record is flagged facilitating searches for enrolled patients in the database.

### Results

The introduction of the computer-based enrollment program improved the enrollment process. First, preoperative clinic staff members were always reminded when an eligible patient entered the clinic, potentially improving enrollment numbers. Second, the automatically triggered instructions for trial placement and randomization helped staff members accurately enroll participants. Finally, automated instructions reduced the need to type in information, which saved time and decreased the potential for error.

### Conclusions

The use of computer-based enrollment in the preoperative clinic setting can improve patient recruitment and decrease errors of enrollment in clinical trials.

## 50ml syringe pumps – Are they suitable for ‘high risk’ infusions ?

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### Introduction

The syringe pump is accepted as the most accurate infusion device for low flow rate infusions. In intensive care, infusion rates as low as 1ml/h are used to cater for a variety of drug administrations. Provided that the pump has been initially run to take up any mechanical slack in the system, the instrument will provide high fidelity of flow over relatively short time intervals suggesting its suitability for high risk infusions.

Researchers have noticed that altering the pump height during infusion can cause unwanted and dramatic flow error.

The mechanism for these flow fluctuations is the expansion and contraction of syringe and line volume when experiencing pressure changes due to changing the fluid height. In this study, a mathematical model was designed to predict flow rate errors in syringe pumps, due not only to change in pump height, but also change in venous back-pressure – an area not previously considered.

### Method

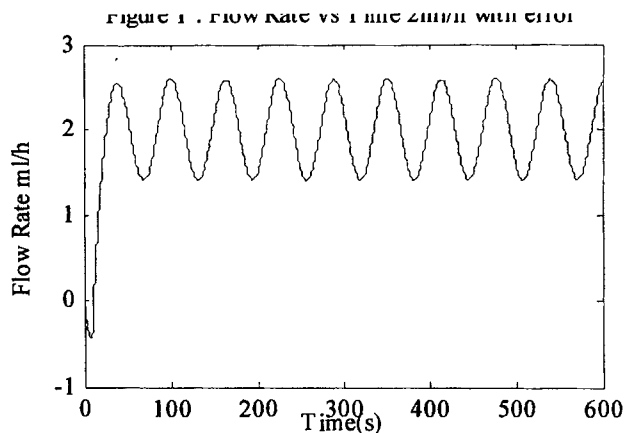
Flow rate error due to the effect of applied pressure on a system with compliance was modelled mathematically as a first order differential equation, based on Poiseuille's Equation, such that :

$$B = (P_2 - P_1) A + C \frac{dP_2}{dt}$$

where B = set flow rate ;  $P_2 - P_1$  = pressure differential across the line cannula restriction with  $P_1$  being cannula exit pressure ; A = constant representing line and cannula restriction ; C = compliance.

### Results

This model was simulated for a typical 50ml syringe pump using standard disposables. MATLAB SIMULINK® software simulation results were compared with actual flow modulation caused by a series of height change scenarios. A close agreement was found between actual and simulated results. A series of simulations was then performed to predict the likely effect on flow rate of changes in venous back-pressure ( $P_1$  in the formula above). Figure 1 shows flow rate errors on a set rate of 2ml/h caused by a +/- 2mmHg sinusoidal venous pressure change of 0.1 rad/s.



### Conclusion

At low flow rates e.g. <5ml/h , changes in pump height or venous pressure can have significant influence on accuracy. In the above example, a flow rate error of +/- 25% resulted from a +/- 2mmHg slow sinusoidal change in venous back-pressure. The errors are proportional to system compliance suggesting that a smaller syringe with rigid line might be a better option for high risk infusions of vaso-active short half-life drugs.

## Target Guided Infusion (TGI): using technology to improve understanding of pharmacokinetic and pharmacodynamic principles

W Bosseau Murray<sup>1</sup>, Ben H Boedeker<sup>\*</sup>, Robert Marine<sup>1</sup>, Celestine Okwuone<sup>1</sup>

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<sup>\*</sup>Univ of NE Medical Center/Omaha VA Medical Center and TATRC, Fort Detrick, MD

Total intra-venous anesthesia (TIVA) using target controlled infusions (TCI) has been used in anesthesia practice for more than two decades. However, due to lack of FDA approval of TCI, the technique is not widely known, understood or used in the USA. We were interested in studying the learning curve and acceptance of TCI principles in an academic medical center.

### Methods:

IRB approval was obtained for studying volunteers from 3 anesthesia provider groups: 24 anesthesia residents, 10 CRNAs and 10 attending anesthesiologists where the use of TIVA was planned for their patients. An FM System (B Braun Medical, Inc., Bethlehem, PA) was used to infuse propofol in a target guided mode where the infusion device continuously calculates and displays: a.) the present blood concentration, b.) the predicted blood concentration over the next 30 minutes given the present infusion rate, and, c.) the time to reach a blood concentration of 1.4 ug/ml (which is the average "wake-up" concentration of propofol.) In this "open loop", target guided (TGI) mode, the clinician adjusts the infusion rate, guided by the calculations. A comprehensive (pre-study) questionnaire explored the perceptions and knowledge of TCI of participants prior to the use of the system. A second questionnaire evaluated changes in perception, confidence, and understanding of participants, after using the system.

### Results:

All groups of participants reported that they typically used TIVA in 1-5% of their cases, and not one of them had used or seen TCI before. Results (*Average ± Standard deviation*) of representative questions are shown in the table; before the participants used the TGI system (*Pre use*) and after they had used the system (*Post use*.)

How sure are you that you: 10 point scale ( <i>not sure</i> to <i>very sure</i> )	Pre use	Post use
- know what the propofol blood concentration is at any given point ?	2.5 ± 1.3	8.5 ± 0.6
- know that the propofol blood concentration has reached a plateau ?	2.0 ± 0.0	9.0 ± 0.0
- can re-establish a depth of anesthesia that was previously sufficient ?	5.3 ± 1.5	8.8 ± 0.5
- know how long it will take your patient to wake up ?	4.0 ± 1.8	8.0 ± 1.2
- know when to switch off the propofol at the end of the surgery ?	4.3 ± 2.1	8.3 ± 1.0

After using the TGI system, the participants:

- rated their comfort level using TGI between 7 and 9.
- rated TGI as better (9 to 10) than constant infusion
- rated their wish to have a TCI system as 9 to 10 on the 10 point scale.

### Discussion:

Based on the results, it seems that the practical hands-on learning improved participants' acceptance, understanding and trust of the TCI technique more than lectures and reading. The TGI method enables rapid learning in the clinical environment, using FDA acceptable devices and techniques, suitable for clinicians required to work in adverse environments where a small footprint is useful and spontaneous breathing is more often encountered.

*This expresses the opinions of the authors and is not intended to represent the opinions and views of the United States Air Force, United States Army or the Department of Veteran's Affairs.*



## Using technology to enhance the safety of technology: another look at GasMan

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General anesthesia using a volatile agent is the dominant method used in the USA. Demonstrating the changes (uptake and elimination) during the start and end of anesthesia places an undue stress on trainees due to the many other events they have to observe and manage.

We studied the value of using a volatile agent simulation program, GasMan (MedMan Simulations, Boston, MA), in a small group setting to enhance the understanding of trainees, and enable them to safely implement general anesthesia using volatile agents.

### Methods:

Self-selected residents were offered 1 hour sessions using GasMan to teach:

#### a. Basic concepts:-

- which factors influencing uptake/elimination
- quantitative assessment of influence of the various factors

Time course involved

#### b. Clinical implications:-

- giving 1 MAC or less for 60 seconds while waiting for rocuronium has minimal effect
- overpressure technique, and why it is safe
- differences in induction and recovery times between agents
- when to switch off agent ( "context sensitive half life" )
- effect of low flows in circle systems

### Results:

During the teaching sessions, the following became apparent:

- residents need a theoretical background first e.g. concepts of Vessel Rich Group, solubility, alveolar minute ventilation, etc.
- residents need significant prior clinical anesthesia exposure in an effort to help them appreciate and understand the questions!
- due to limited time, residents did not spontaneously follow-up on the teaching session
- residents had difficulty exploring the program on their own
- the clinical validity and reliability is not readily apparent to users

### Discussion:

There is a great need and desire for more understanding of volatile agent anesthesia principles as evidenced by frequent questions from trainees. Trainees have difficulty (lack of time, motivation and understanding) in self-study using existing resources such as the Internet and computer based simulation programs. They seem unable to "play" with the programs and develop a syllabus on their own by asking (and answering) questions and hypotheses. Trainees readily grasp the complex concepts when these are presented in a small group setting, at an appropriate speed, and without the stress of the clinical environment. We believe patient safety will be enhanced due to the increased understanding of volatile agent physics and pharmacology, which is engendered by the use of simulations such as GasMan.

**Patient Safety Initiative –  
Information Technology Solutions to Improve Patient Safety in the State of Florida**

**Review of Field Interviews and Survey of Hospital's CEOs**

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The current status of implementation of Electronic Health Records (EHR) and clinical Health Information Systems (HIS) in Florida indicates a mixed strategic trend, which may hinder patient safety. The Miami Center for Patient Safety conducted a survey among 200 Florida hospital CEOs to assess their strategic plan and the level of implementation of HIS in Florida. Over 60% (121/200) of the executives responded to a web-based questionnaire and extensive field interviews in 2004. 83% currently use HIS for administration, scheduling and resource management; 16% will add such systems within the next year. Although 75% of CEOs ranked the EHR as "important" or "very important", only 51% implemented it or plan to implement it within the next year ("current users"). Among "current users", 67% see the value of a State-wide Health Information Infrastructure (HII), and only 37% of "non-users" see such value. Analysis of pharmacy information systems data indicates that only 49% are "current users". 42% of "current users" and 100% of "non-users", object to share pharmacy data with other hospitals. This data indicates that hospitals CEOs are still not convinced that clinical HIS is essential for patient safety nor necessarily believe that investment in HIS align with their organizational development plans. It is imperative that patient safety advocates, clinicians and researchers contribute their efforts to change this understanding and mindset.

## Use of a Computer Model of Volatile Anesthetic to Estimate Emergence Time, With and Without CO<sub>2</sub> Rebreathing

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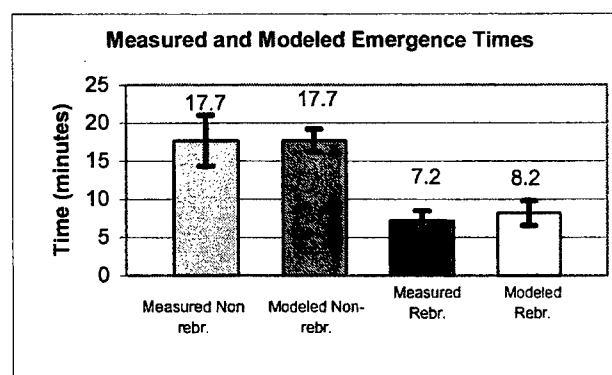
**Introduction:** Computer modeling allows us to test a clinical intervention over a wide range of patient types and conditions. We used a computer model of anesthetic uptake to compare emergence times from isoflurane anesthesia with and without a CO<sub>2</sub> rebreathing/anesthetic absorber.

**Methods:** We implemented a model of anesthetic uptake and distribution in Borland C++ Builder version 5.0 for windows (Borland, Scotts Valley, CA). The model is based on the work of JG Lerou and describes transport of anesthetic in the arterial and venous blood as well as the flow of volatile anesthetic agents in the breathing circuit and in the pulmonary alveoli. We modified the model to simulate use of a rebreathing/absorber device. The modification allows the simulated patient to inhale CO<sub>2</sub> from the previous breath that was stored in the rebreathing hose. The model also assumes that the charcoal in the device absorbs all of the volatile anesthetic so that none is inhaled when the device is activated. We also modified the model to alter cerebral blood flow according to the partial pressure of alveolar (end-tidal) CO<sub>2</sub>, using the relationship published by Ide et al.

Data from 20 surgical patients was used to evaluate the accuracy of the computer model. In a clinical trial, patients having knee surgery (ACL repair) were anesthetized using 1 MAC of isoflurane for an average of 2.5 hours. Patients were ventilated at 8 breaths per minute and tidal volume was adjusted to maintain end-tidal CO<sub>2</sub> at 33 mm Hg. At the end of surgery the rebreathing absorber device was used to speed emergence in 10 of the 20 patients. For ten patients the device was insert the into the breathing circuit when the vaporizer was to turned off, the respiratory rate was double, and the tidal volume was increased by about 200 ml. The anesthesiologist verbally prompted the patient to wake up every 30 seconds. For the ten patients that did not use the rebreathing device, the, fresh gas flow was increased to 10 l/min but ventilation remained unchanged.

We used the recorded details of this testing to evaluate the accuracy of the computer simulation. Patient details including age, sex, height and weight were entered into the model. Duration of the anesthetic was also entered and the simulated tidal volume was adjusted to achieve a maintenance end-tidal CO<sub>2</sub> of 33 as in the clinical trial. The emergence protocol was simulated for each of the patients.

**Results:** The graph shows the measured and modeled emergence times for the rebreathing and non-rebreathing patient groups. Measured times are the times between turning off the isoflurane vaporizer and extubation. Simulated emergence times are the time between turning off the simulated vaporizer and when the simulated concentration of anesthetic in the brain fell to below 0.4 MAC. The measured time to extubation was  $17.7 \pm 4.7$  minutes for the non-rebreathing patients versus the simulated time of  $17.7 \pm 3.4$  minutes. The measured emergence time for the rebreathing patients was  $7.2 \pm 2.1$  minutes compared to  $8.2 \pm 1.6$  minutes for the simulation. The average difference in actual and simulated emergence time was less than 1 minute for both groups



### References

JG Lerou, RD Dirksen, HH Beneken Kolmer, LHDJ Booij: A system model for closed-circuit inhalation anesthesia, computer study; *Anesthesiology* 75:345-355, 1991

K Ide, M Eliasziw, MJ Poulin: Relationship between middle cerebral artery blood velocity and end-tidal PCO<sub>2</sub> in the hypocapnic-hypercapnic range in humans; *J Appl Physiol* 95:129-137, 2003

## Evaluation of a Device to Speed Emergence from Volatile Anesthetic Using a Computer Model

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**Introduction:** We used a computer model of anesthetic uptake and distribution to evaluate the expected emergence time reduction when using a rebreathing/absorber device. The computer model describes transport of anesthetic in multiple body tissue compartments as well as in the breathing circuit. We modified the model to simulate use of a rebreathing/absorber device. The modification allows the simulated patient to inhale CO<sub>2</sub> stored in the rebreathing hose from the previous breath and assumes that charcoal filter in the device will absorb all of the anesthetic gas so that none is inhaled during emergence. We also modified the model to alter cerebral blood flow according to the partial pressure of alveolar (end-tidal) CO<sub>2</sub> using the relationship published by Ide et al.

**Methods:** We simulated 9 combinations of patient size and anesthetic duration for each of four anesthetic gases. All simulated patients were 30-year-old males. Age and gender affect the modeled alveolar volume and the relative volume of lean and adipose tissue. The simulated patients include a small (weight 50 Kg., height 160 cm), medium (weight 70 kg, height 183 cm.) and obese patient (weight 150 kg, height 183 cm).

All simulated patients received 1 MAC of anesthetic for durations of 30 minutes, 2 hours, or 8 hours. Maintenance conditions called for ventilating patients at 10 breaths per minute. Simulated tidal volume was set to maintain etCO<sub>2</sub> at 33 mm Hg. Fresh gas flow was set to 3 liters per minute. Fresh gas flow was increased to 10 liters per minute for both non-rebreathing and rebreathing emergence tests. In non-rebreathing emergence simulations, respiratory rate and tidal volume remained constant. In rebreathing simulations, respiratory rate was doubled and tidal volume was increased by 200 ml during emergence.

**Results:** Average percent decrease in emergence time was 54% for isoflurane, 45% for sevoflurane, 47% for desflurane and 59% for halothane. Overall, the greatest advantage is seen in the more soluble anesthetics (isoflurane and halothane). The smallest time reduction (36%) was seen when simulating a small patient, receiving desflurane for a 30 minute anesthetic. The results also show the total amount of anesthetic exhaled from the patient during the emergence process. The data shows that the average volume of anesthetic excreted during emergence using the rebreathing/absorber device is 3% less than the amount excreted during a normal (non-rebreathing) emergence.

**Discussion:** As in most computer models, this simulation does not account for inter-patient variability, which the model does not simulate. These variables include differences in metabolic rate, cardiac output, tissue volume variations etc. This model simulates metabolic production of CO<sub>2</sub> as a constant value that is determined according to patient weight. Our model does not consider variation in metabolic rate or cardiac output caused by surgical stimulation, pain, catecholamine release, etc. These variables may lead to variability in patients that the model will not simulate.

### References

JG Lerou, RD Dirksen, HH Beneken Kolmer, LHDJ Booij: A system model for closed-circuit inhalation anesthesia, computer study; *Anesthesiology* 75:345-355, 1991

K Ide, M Eliasziw, MJ Poulin: Relationship between middle cerebral artery blood velocity and end-tidal PCO<sub>2</sub> in the hypocapnic-hypercapnic range in humans; *J Appl Physiol* 95:129-137, 2003

# Electrocardiogram is an Inaccurate Indicator of Cardiac Function

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**Introduction:** Left ventricular Hypertrophy (LVH) is a known marker for increased cardiovascular morbidity and mortality. Older patients with left atrial enlargement (LAE) may already have compromised cardiac function and require further preoperative evaluation to optimize anesthetic care. The objectives of this study are to: a) determine the sensitivity of ECG in identifying the presence of LVH, b) establish a correlation between left ventricular systolic function as determined by 2-D echocardiogram (ECHO) to ECG evidence of LVH and LAE.

**Methods:** Population based retrospective case control study. ECHO reports of patients from September 2002 - December 2002 was reviewed. Patients with ECHO evidence of LVH based on modified Devereaux criteria were identified. Their 12 lead ECG was reviewed for the presence of LVH using established criteria. Left ventricular mass (LVM), Left atrial size, ejection fraction, <50/ >50%, age and gender for these patients were analyzed. Chi square tests were used to compare LVH by ECHO and ECG findings of LVH, LAE and to left ventricular systolic function. Linear regression analysis was used to determine differences in age and gender.  $P < 0.05$  was considered significant

**Results:** 234 patients (106 men (M), 128 women (W) ages: 63 +/- 13 with presence of LVH by echocardiogram were identified. 63/106 M, 29/128 W and 92/234 overall (T) had positive ECG findings for LVH (sensitivity 59, 23 and 40 % respectively). There was a significant correlation between presence of LAE on ECG and LVEF [T:  $p < 0.01$ , M:  $p < 0.01$ , W:  $p < 0.01$ ]. Although there was an overall significant correlation between LAE and LVM; (T:  $p < 0.01$ , M:  $p < 0.01$ ) it was not statistically significant for women ( $p > 0.05$ ). Likewise, the overall correlation between LAE to age [T:  $p = 0.02$ , M:  $p = 0.02$ , W:  $p > 0.05$ ] was not statistically significant in women. There was no significant correlation between LAE by ECG to LVH by ECG ( $p > 0.05$ ). Comparison between LVH on ECG to LVEF by ECHO listed in table: 1.

TABLE: 1

Ejection Fraction (%)	LVH +on ECG	LVH – on ECG -	Sensitivity (%)	Specificity (%)
<50	24	23	51	48
	8	14	36	63
	32	37	46	53
>50 %	19	40	32	67
	24	82	23	79
	43	122	26	74

**Conclusion:** The presence of LVH on ECG lacks sensitivity in identifying individuals with altered systolic function. The sensitivity of the ECG for detection of LVH is significantly better for men as compared to women. This may be due to random sampling variability. Older patients with LAE on ECG have significantly reduced LVEF. This may suggest that older individuals with LAE of ECG require further work-up to assess cardiac function.

## **Wireless Local Area Network (WLAN) for Anesthesia Record Keeping**

### **Can you depend on them for your data:**

Mohamed A. Rehman, M.D., Roy E. Schwartz M.D.

We report 2 year experience of the first fully functional wireless Compurecord<sup>1</sup> Peri-operative Anesthesia WLAN. The system has been used for pre-operative patient evaluation, anesthesia record keeping and billing.

#### **Hardware:**

Dell True mobile 1150 series WLAN hub, Desktop PCs (Pentium 3) with True Mobile 1150 series WLAN adapter card

#### **Software:**

Microsoft Windows 2000, Microsoft office XP, Dell True Mobile 1150 client manager software, Compurecord version C.08.05, Electronic Patient folder – McKesson – Version 4.50.4, Invision for access to Sunquest laboratory data

A WLAN hub provides an 802.11b connection between the operating room record keeping system, pre-anesthetic evaluation module in the pre-operative holding area and the main Compurecord server. Patient data was readily available to the anesthesiologist performing the pre-anesthetic evaluation. Anesthesia providers in the operating room can readily access the pre-operative information and electronic patient folder. We noticed no obvious interference with any of the monitors or the ventilator.

A log was maintained by the Information technology department on WLAN network issues over 24 months. There were 3 events necessitating intervention.

- 1) 2 wireless cards failed needing replacement.
- 2) 1 wireless card driver was corrupted needing reinstallation of driver.

#### **Conclusions**

- 1) WLAN can be reliably used in the operating room for computerized record keeping system.
- 2) Great potential exists for expandability and implementation of new devices like Tablet PC<sup>2</sup>.

#### **Bibliography:**

1. Compurecord is the trademark of Philips Medical Systems
2. Enhancing the Performance of Anesthesia Services by Implementing a Perioperative System utilizing Tablet PCs.  
Mohamed A. Rehman, M.D., Roy E. Schwartz, M.D.  
Abstract presented at Society for Technology in Anesthesia  
January 2004. Anesth Analg 2004;98,S1-S43

## Time Domain Analysis of the Photoelectric Plethysmograph Waveform

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**BACKGROUND:** In the process of determining oxygen saturation the pulse oximeter functions as a photoelectric plethysmograph. In this role, it non-invasively measures the change of blood volume of a vascular bed (finger, ear or forehead). The change in blood volume is the result of the influences of arterial, venous, autonomic and respiratory systems on the peripheral circulation. Normally the clinician is only presented with a highly filtered waveform consisting of an AC (pulsatile) component which has had its amplitude auto gained and centered. The DC (nonpulsatile) component is frequently viewed as unimportant and is discarded as artifact. Two methods, of extracting these two components, exist using either spectral (Shelley, Stout et al. 1999) or time domain analysis. The ability to separate the plethysmographic signal into its fundamental components may allow for analysis of both pre-load (DC) and after load (AC) conditions.

**METHODS:** Patients undergoing a wide range of surgical procedures were studied with IRB approval. They all received a standard general anesthetic technique and were ventilated with positive pressure via an endotracheal tube. In addition to the standard monitors for anesthesia, reflective IR plethysmographic probes were placed on the finger (clip), forehead (Tegaderm adhesive) and ear (clip) (MLT1020 - ADInstruments, Colorado Springs, CO) and these signals, along with the CO<sub>2</sub> and airway pressure waveforms, were recorded at 100Hz (ML795 - ADInstruments). The recorded waveforms were analyzed using routines written with Igor Pro software (v 5.02; Wavemetrics, Lake Oswego, OR).

### Time domain analysis

The plethysmograph signal was run through an algorithm to identify maximums and minimums of the waveform, which were then filtered by size and frequency of occurrence to ensure that only the most extreme-valued points for any given heartbeat were recorded, avoiding accidental recording of small venous pulsations or extraneous artifact such as movement by the patient.

The AC (pulsatile) component is the change in the amplitude of the waveform, independent of its baseline. It is determined by taking the difference between adjacent maxima and minima. When the difference between maxima and minima was constant throughout, then the wave's amplitude was constant as well, indicating no modulation of the AC signal, while when the difference between maxima and minima increased and decreased rhythmically on a respiratory time scale, a modulated AC signal was present. The DC (non-pulsatile) component is the measurement of the center position of the waveform, as determined by taking the average of adjacent maxima and minima. When the center position moves rhythmically on a respiratory time scale, a modulated DC signal is present.

**RESULTS:** A total of 53.3 hours (18 cases; mean 2.96 hrs  $\pm$  1.13) of waveforms was collected and analyzed. Time domain analysis demonstrated a high degree of correlation with spectral techniques for both depth and frequency of ventilation. In addition, time domain analysis was less dependent on the regularity of ventilation. On the other hand, time domain analysis was more susceptible to isolated artifacts, such as patient movement, when compared to spectral methods. Of note, AC modulation was never observed without the presence of strong DC modulation, no matter what method of analysis was used.

**CONCLUSIONS:** It is likely that the best method of analysis used to measure the impact of ventilation on the plethysmographic waveform will be a combination of the time domain and spectral approaches. Ultimately, spectral analysis may prove to be more useful with positive pressure ventilation (due to its regularity) and time domain analysis more effective with spontaneous ventilation (allowing for a breath by breath analysis).

Shelley, K. H., R. G. Stout, et al. (1999). "The use of joint time frequency analysis of the pulse oximeter waveform to measure the respiratory rate of ventilated patients." *Anesthesiology* 91(3A): A583.

**Title: Evaluating the Performance of Closed Loop Controllers in Anesthesia**

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**Introduction:** The automotive, aviation and medical industries use closed loop control in many of their critical applications. Controllers often outperform human operators. Controllers enhance the human operators capability, particularly when the operator is tired, distracted or under stress. In most applications, the primary outcome is enhanced safety.

**Methods:** Since the FDA approved IVACs sodium nitroprusside controller in 1988, other controllers have been added to commercially available medical devices:

1. Ventilators have closed loop controllers that regulate the minute volume delivered, to automatically supplement a patients spontaneous respiration and to automatically compensate for changes in airway resistance and lung compliance.
2. Airway humidifiers use closed loop control to adjust the temperature of the gas they deliver.
3. Incubators have a controller that adjusts the heat delivered, to keep a neonates skin temperature constant.
4. Arrhythmia detection algorithms have controllers that automatically update their rhythm detection templates, increasing the accuracy of event detection.

Each of these closed loop controllers have been found to:

1. Quickly reach the desired target, without excessive overshoot,
2. Accurately maintain the controlled variable at the target level, and
3. Maintain their performance specifications over a wide range of operating conditions.

In anesthesia, it is reasonable to introduce closed-loop control systems that control drug delivery [1]. Because the majority of drugs used have short onset and offset times, they are good candidates for closed loop control [2]. Controllers may well help to provide better and safer drug management. The aim of this paper is to propose an evaluation procedure for such controllers.

**Results:** We propose to evaluate the performance of closed-loop control systems in terms of:

1. Set point precision: the ability to minimizing the difference between the target and the controlled variable. Static parameters measure the precision during steady state periods and dynamic parameters measure the time and overshoot to reach a new target setting and to reach steady state after a rapid change of the controlled variable.
  2. Safety: describe periods when the controlled variable is unacceptable, number of critical incidents and manual interventions.
  3. Outcome/Benefit: describe the quality of anesthesia, including post anesthetic outcome and cost.
- Testing shall be conducted over the entire range of conditions expected clinically for the intended use of the system. To cover this range some of the tests may be carried out in simulation. To be clinically acceptable, a controller's performance should be comparable to or better than a human operator's performance.

**Conclusions:** Closed loop controllers can help a clinician deliver more rapid, precise and patient specific therapy. They will become clinically acceptable when they are designed, tested and applied with focus on patient safety.

Ref: [1] Anesthesiology 2001;95:6-17; [2] Anesth Analg 1996;83:901-3.



## **Use of Compuflow® for the identification of the epidural space - a preliminary study**

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The COMPUFLO® (Milestone Scientific, Livingston, NJ; US Patent 20030078534, US patent 6,200,289 B1) is a computerized syringe pump capable of volume and pressure controlled infusion. It has a pressure sensor and a mathematical algorithm capable of determining the pressure at the needle tip. Pressures are continuously monitored, displayed and reflected by changes in tone.

We performed a preliminary study aimed at checking if the use of this device is feasible for the identification of the epidural space.

After institutional approval and signed informed consent 20 patients were enrolled. The identification of the epidural space was performed using the loss of resistance technique.

When the operator believed that the needle is in the supraspinous ligament, flavum and in the epidural space, a 20cc BD saline filled syringe attached to a Meritans™ pressure transducer and a 48 inch pressure line was attached to the needle and an infusion at 0.08 ml/min with an upper pressure limit of 600 mm Hg was started.

The pressure and volume infused were recorded every second for at least 7 seconds in each location. The volume infused over 7 seconds divided by the pressure increase was calculated as a measure of the tissue compliance.

### **Results:**

The COMPUFLO® clearly distinguished between the tissue compliance of the ligaments and the compliance of the epidural space.

### **Bibliography**

Masui. 2002 Aug;51(8):927-30.  
Anesth Analg 2003; 96: 1183-7

## Arterial Pulse Wave Reflection Assessed Using Suprasystolic Brachial Artery Recordings

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### Introduction

Arterial tone can be assessed non-invasively by measuring the amplitude of arterial pulse wave reflection using arterial tonometry (1). These devices are somewhat difficult to position making them unsuitable to intermittent monitoring in the anesthetic/intensive care environment.

Low frequency (non-audible) signals can be recorded from the brachial artery beneath a blood pressure cuff inflated above systolic pressure (2). This study was undertaken to determine whether these signals could be used to identify arterial pulse wave reflections.

### Methods

Following Institutional Review Board approval, 25 patients undergoing coronary angiography consented to participate. Ascending aorta pressure and EKG were recorded continually. Concurrent recordings from a piezoelectric sensor placed beneath the distal border of a blood pressure were made with the cuff inflated above systolic pressure. The timing of the incident pulse wave (SS1), the initial reflection wave (SS2) and third wave (SS3) were related to the contour of the ascending aortic pressure trace.

### Results

In all patients, the second wave (SS2) corresponded to the late systolic phase of the aortic pressure trace. A typical tracing is shown in figure 1.

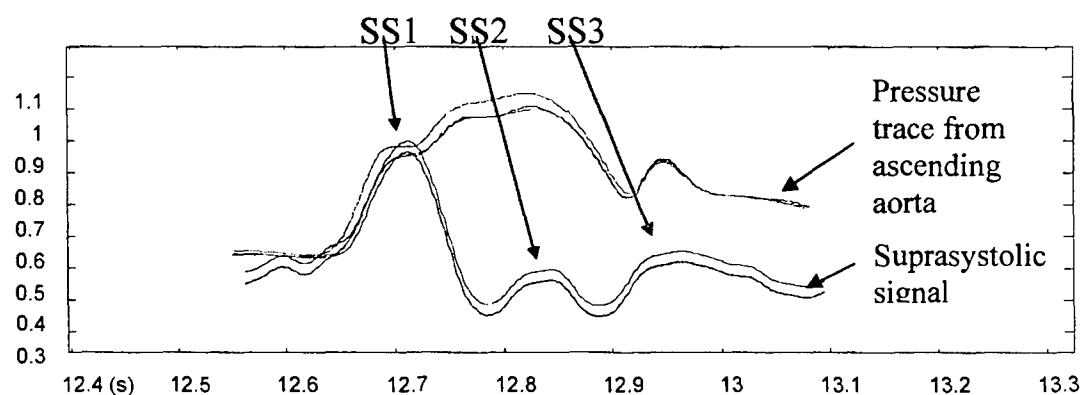


Figure 1: Comparison of ascending aorta and suprasystolic waves

### Conclusion

Analysis of suprasystolic pressure signals provides a simple non-invasive means of measuring arterial pulse wave reflection. A monitoring system assessing these waves has been developed which can be used to assess arterial stiffness and changes in arterial tone in the anesthetic/intensive care environment.

### References

1. Oliver JJ, Webb DJ. *Arterioscler Thromb Vasc Biol* 2003;23:554-66.
2. Denby L, Mallows CL, Blank SG. *Statistics in Medicine* 1994;13:275-91.

## Encoding Urgency into Auditory Displays to Improve Patient Monitoring

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**Introduction:** Most auditory alarm signals (AAS) have an urgency-mismatch. International standards stipulate that AAS should be priority-encoded. We present a multi-disciplinary approach to AAS development that matches AAS acoustical structure and function so that anesthesiologist performance is maximized.

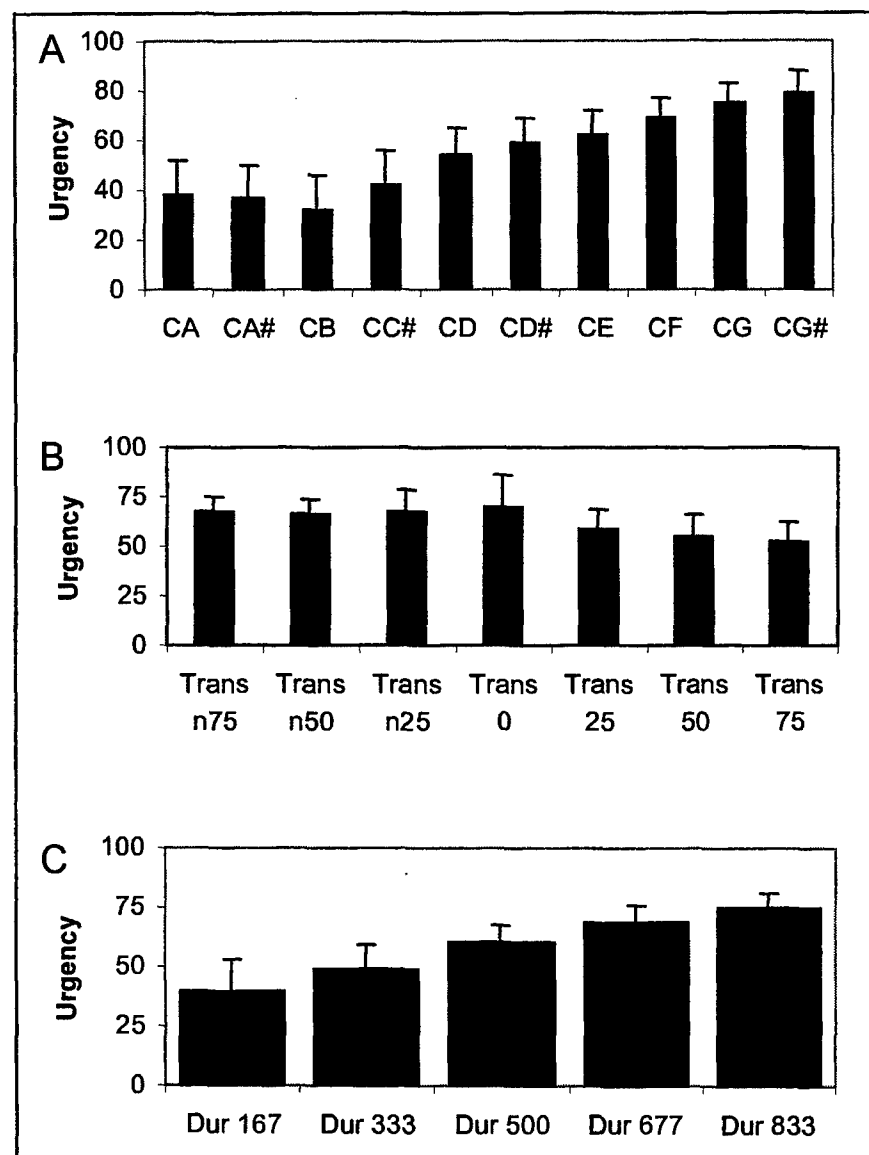


Figure. Urgency rating analysis of AAS sets. Urgency is shown for set I (A), set II (B), and set III (C). Vertical bars are 95% confidence intervals.

appear to follow Steven's power law—implying a psychophysical basis. The ADCS II had the highest T and S/N. Since the acoustical dimensions presented in set II were perfectly aligned while those in set I were not, the results suggest that the number and alignment of acoustic dimensions are important in efficacy of urgency information transmission.

**Methods:** Three sets of AAS were designed that varied as follows: set I—beat period, average pitch, and dissonance; set II—tone overlap and average sound pressure; and set III—tone duration. Eleven subjects rated the AAS for urgency. Then the AAS were mapped to one of five priority categories depending on urgency rating. Using the method of categorical judgments, the function of the resulting auditory display communication systems (ADCS) was assessed by measuring channel capacities (T) and signal-to-noise ratios (S/N).

**Results:** Subjects rated AAS for urgency (figure). The urgency data ( $\Psi$ ) from set I was plotted against beat period ( $\Phi$ ) and fit to a power equation:  $\Psi = 10.7\Phi^{0.35}$  ( $R^2 = 0.83$ ). Data from sets II and III were fit to linear equations. The calculated values T (bits) and S/N were: ADCS I-1.41(+/-0.22) and 1.55; ADCS II-1.71(+/-0.28) and 2.80; and ADCS III-1.30(+/-0.14) and 1.27.

**Discussion:** The urgency ratings were consistent across subjects. The data from set I

## Evaluation of a Vibro-Tactile Display Prototype for Physiological Monitoring

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Visual displays and auditory alarms are used to convey physiological parameters in an operating room. However, the exponential growth of the number of these parameters and the high probability of false alarms amplify the demands on clinician attention. We have extended existing tactile technology to improve situational awareness and produce a practical clinical advisory device.

A vibro-tactile display, using two vibrating motors applied to the volar surface of the forearm, see Figure 1. It was compared to an auditory alarm in a simulated clinical environment. The ease of learning stimulation patterns, identification rate, identification accuracy, response time and user acceptance were compared in 10 participants with no anesthesia training.

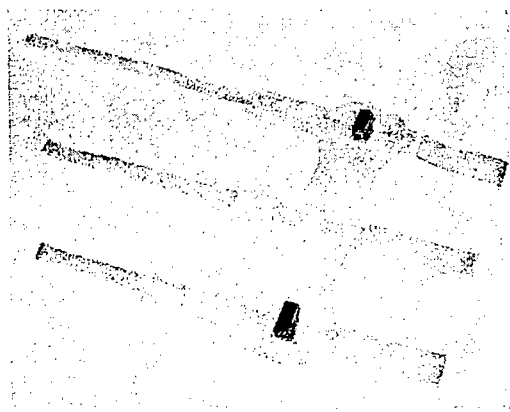


Figure 1. Vibro-tactile display prototype

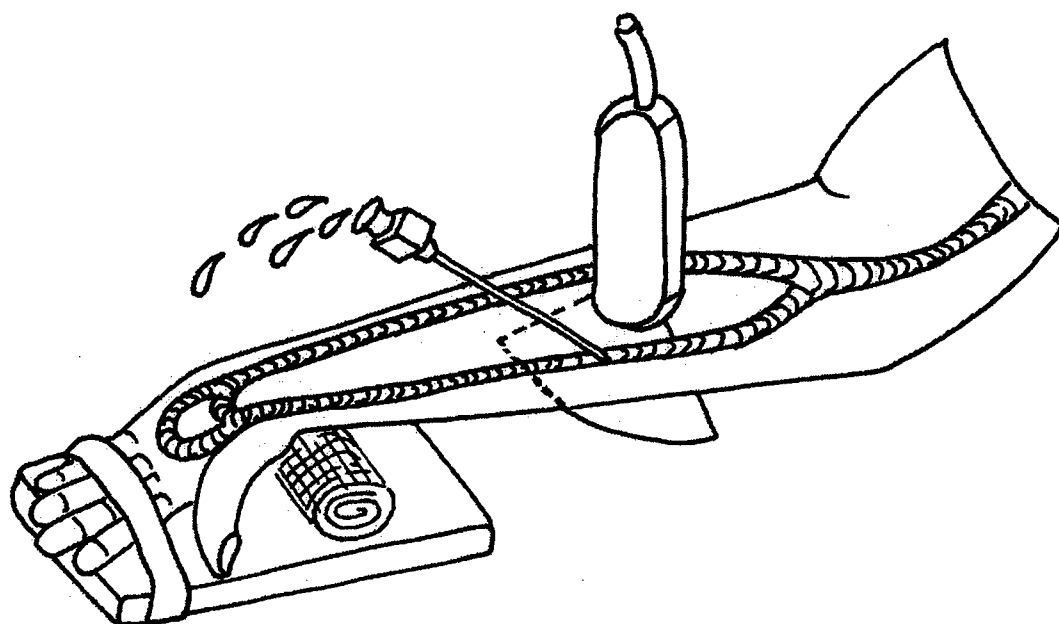
The vibro-tactile alarm was easier to learn than the auditory alarm ( $p < 0.05$ ). The performance of the vibro-tactile alarm was significantly better than the auditory alarm in identification rate ( $p < 0.002$ ) and accuracy ( $p < 0.002$ ). Surprisingly, the combined vibro-tactile and auditory alarm was not better than the vibro-tactile alarm alone due to an increased rate of misinterpreted alarms. Most users preferred the vibro-tactile alarm although the current prototype did cause some discomfort.

The optimal site, stimulation modality and stimulation pattern for a clinically useful tactile display remain to be determined. This investigation suggests that the vibro-tactile alarm is superior to the auditory alarm in attracting attention with a lower misinterpretation rate. The reduced performance of the combined vibro-tactile and auditory alarm compared to the vibro-tactile alarm alone warrants further investigation. The vibro-tactile alarm shows considerable promise as an alarm modality in clinical practice but requires further testing and refinement especially with regard to comfort.

## Ultrasound Guided Mid-Forearm Approach as a Rescue Technique for Failed Radial Artery Cannulation

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Radial Artery cannulation at the wrist by palpation is occasionally unsuccessful and may result in a hematoma, vasospasm or intimal dissection. Doppler and ultrasound has been used as a primary technique to aid radial artery cannulation at the wrist.<sup>1,2</sup> In cases of failed cannulation, imaging of the artery in this location becomes difficult. Ultrasonography can be employed in the mid-forearm to image and cannulate the radial artery beneath the brachioradialis muscle. We have used ultrasound in over 30 cases as a rescue technique following unsuccessful attempts at distal radial artery cannulation. The technique and a typical case are detailed. **Technique:** An ultrasound device (Sonosite, Bothell, WA) is used to image the radial artery in the middle third of the forearm. Pulsations of the artery are easily seen with the transverse image. The skin entry site, 1-2cm distal to the probe, is cleaned with alcohol. A cannula is inserted at a 45 degree angle towards the middle of the probe until it is visualized puncturing the anterior and posterior walls of the artery. The needle is withdrawn and the cannula is pulled back slowly until pulsatile blood is obtained (fig 1).



**Case Example:** 40 year old man rescued from the debris of a crashed building presented with bilateral lower extremity compartment syndromes and rhabdomyolysis. The radial artery was difficult to palpate due to severe edema and vasopressor infusion. Ultrasonography was used to locate and cannulate this constricted artery.

**Discussion:** Imaging of a previously compromised artery is difficult due to vasospasm and hematoma. We have used ultrasound to localize the radial artery more proximally where it is not palpable. In our experience using a transverse image of the artery provides good visualization of the artery and the needle traversing through it. Limitations of this technique include the need for a longer cannula for the patient with a bulky brachioradialis muscle. The cannula may also kink with movement of the muscle in the awake patient.

Ref: 1) Maher JJ, Dougherty JM: *Am J Emerg Med* 1989; 7: 260-262

2) Levin PD, Sheinin O, Gozal Y *Critical Care Medicine* 2003; 31(2):481-4

## PROPOSAL FOR A UNIQUE AND UNIVERSALLY APPLICABLE WIRELESS INTERFACE SYSTEM FOR PATIENT MONITORING DURING TRANSPORT

Passik, C. S., MD, Rafferty, T.D., MD, MBA and Fusco, D.S., MD, MS

### PROBLEM STATEMENT

The clinical status of critically ill operative and intensive care unit patients is routinely assessed from data derived from a wide variety of non-invasive and invasive transducers. Non-invasive transducers include electrocardiogram skin electrodes blood pressure measurement devices, pulse oximeters, capnographs and thermistors. Invasive transducers include transducers for measuring intra-arterial, pulmonary artery, central venous and intracranial pressures. They also include intravascular thermistors used in determining cardiac output and intravascular oximeters. The resulting measurements are optimally presented on a single fixed display monitor. While this monitoring provides continuously available data in the operative and intensive care unit setting, these real-time data are not always available during the patient transport process. This problem occurs for the following reasons: First, changeover from fixed to portable display consoles requires disconnecting the relevant cables and recalibrating multiple transducers. This causes a gap in monitoring; Second, potentially crucial variables are often not monitored at all during actual transport because of the inadequacy of currently-available transport display monitors; Finally, arrival at the patient transport destination, again, involves cable disconnection and transducer recalibration, repeating the initial monitoring gap.

### PRODUCT OVERVIEW

We propose a wireless interface system whereby the patient can remain continuously monitored throughout the entire relocation process. The product shall have the following general characteristics:

- a) Electronic interfaces must be wireless;
- b) The range should be sufficient to allow continuous communication between origin and destination fixed display monitors, with 10 feet-separation minimum;
- c) Transmitted patient data must be uniquely identifiable;
- d) Transmitters must be impervious to electromagnetic or motion artifact interference;
- e) The product must be capable of interfacing seamlessly with display monitors from multiple manufacturers.

### PRODUCT SPECIFICS

The product shall consist of two modules, a transmitter module and a receiver module.

#### *The transmitter module*

The transmitter module shall process the input data and convert it to a wireless format for transmission. Input signals will be from the following transducers:

- a) Electrocardiogram skin electrodes;
- b) Non-invasive blood pressure measurement devices;
- c) Pulse oximeter;
- d) Capnograph;
- e) Non-invasive thermistor;
- f) Pressure transducers for measuring intra-arterial, pulmonary artery, central venous and intracranial pressures;
- g) Intravascular thermistors used in determining cardiac output;
- h) Intravascular oximeter.

The transmitter module wireless output signal shall uniquely identify the patient and transducer data source.

#### *The receiver module*

The receiver module shall receive the already uniquely identified wireless signal. The data shall be converted into a format that can be interpreted by display monitors. The receiver module shall be capable of being physically inserted into the input jacks of currently available display monitors. Subsequent prototypes should include a receiver module that is an integral part of a display monitor.

# EVALUATION OF THE TONGUE AND HARD PALATE AS ALTERNATIVE SITES FOR THE REFLECTANCE PULSE OXIMETRY MONITORING IN DIFFICULT TO MONITOR SURGICAL PATIENTS.

Authors: Redford, D., MD, Lichtenthal, P.R., MD, Barker, S.J., PhD, MD

Affiliation: Department of Anesthesiology, University of Arizona Health Science Center

**Introduction:** Pulse oximetry is typically monitored on the extremities. Alternative sites for monitoring pulse oximetry have been evaluated including the ear, nose, lip and forehead, with varying success. In certain patient populations (trauma) use of the oral cavity may prove to be an additional useful site for monitoring SpO<sub>2</sub>. We set out to evaluate various sites in the oral cavity for this purpose.

**Methods:** All patients enrolled were considered difficult to monitor, due to various physical and surgical conditions. We modified an oral airway to incorporate a Masimo TF-I reflectance sensor such that the sensor was positioned on the base of the tongue. After IRB approval, we evaluated 5 surgical patients. After these initial patients, the airway was modified again to position the sensor against the hard palate and 11 additional patients were monitored. In addition to standard surgical monitoring, patients were monitored with Nellcor's N595 (Max-A sensor), Masimo's SET Radical (LNOP Adt sensor) as controls and test sensors Masimo's SET Radical TF-I on either the tongue or the hard palate. SpO<sub>2</sub> and pulse rate from three sensors were continuously logged on computer throughout surgery. Error is the difference between either of the tongue or hard palate sensors and mean of two digit sensors during stable patient conditions. Data were analyzed using bias (mean error) and precision (standard deviation of error) for each patient, E-7 (percentage of time which error was greater than 7% during stable conditions) and performance index (percentage of time which SpO<sub>2</sub> reading is within 7% of control value).

**Results:** A total of 16 patients were evaluated. Mean age, weight and ASA status were not different between the groups (see table). Bias and precision data is presented in table below. The tongue sensor failed (E7% > 20% of the case) in 3 of the 5 subjects (60%). For this reason further evaluation of the tongue was halted. The hard palate sensor failed in only 2 of 11 (18%) subjects studied.

**Discussion:** In this population of difficult to monitor patients, we found the tongue does not produce reliable monitoring results. The hard palate may provide an additional monitoring site although further development is necessary.

Table:

	TF-I on tongue	TF-I on hard palate
Age (mean $\pm$ SD) years	46 $\pm$ 18	45 $\pm$ 19
Weight (mean $\pm$ SD) kgs	98.6 $\pm$ 30	82.2 $\pm$ 16.4
ASA status (mean $\pm$ SD)	2.8 $\pm$ 0.8	1.9 $\pm$ 0.7
Control digit sensors (bias $\pm$ precision)	-1.31 $\pm$ 0.71	-.01 $\pm$ 0.37
Bias (mean $\pm$ SD)	-4.76 $\pm$ 8.89	-1.19 $\pm$ 2.13
Precision (mean $\pm$ SD)	2.41 $\pm$ 1.84	1.75 $\pm$ 1.48
E7 % of case (mean $\pm$ SD)	31.2% $\pm$ 28.9%	6.5 $\pm$ 11.8
Performance Index (%)	68.8%	93.5%

## The Acoustic Sensor for Monitoring Ventilation of Separate Lungs

Shai Tejman-Yarden, MD  
Soroka Medical Center, Israel

One lung intubation (OLI) is a major incident during endotracheal intubation. Monitoring methods used today have been found to be non specific and controversial regarding its early diagnosis. We have developed a system which detects OLI based on electronic lung sounds analysis during artificial ventilation.

Methods: Twenty adult surgical patients were sampled after obtaining an informed consent. The patients' lung sounds were sampled by four piezoelectric microphones. After induction, the tube was inserted and advanced down the airway so that no left breath sounds were heard; the tube was then withdrawn stepwise until equal breath sounds could be heard and the final position of the tube was confirmed by a fiber optic bronchoscope.

The developed algorithm assumes a MIMO (Multi Input Multi Output) system; in which multi-dimensional AR model relates the input (lungs and other sources) and the output (recorded sounds). The unknown AR parameters are estimated, and a classifier based on the estimated eigenvalues of the covariance matrix of the sources indicates while analyzing, the number of lungs ventilated on each breath sound recording.

Results: Assuming the AR model and selecting the second highest eigenvalue of  $\mathbf{R}$  matrix as a classifier for the left lung, gave us a probability of right OLI detection of 92% with a probability of 5 % false alarm. We found more than 90% correct data when correlated with those obtained by the bronchoscope. We can assume even higher values of detection, depending on the sensitivity wanted, taking in mind higher incidence of false alarms.



## **The Use of PDAs in the Storage and Retrieval of Anesthesia Pre-Operative Assessments**

Sanjay Tewari MD, Thomas J.J. Blanck MD PhD, and Jung T. Kim MD  
Department of Anesthesiology, New York University Medical Center, New York, NY

### **Introduction:**

New York University Medical Center, a tertiary referral center, receives many transfer patients from numerous hospitals. Often our patients are elderly, new immigrants, ventilator dependents, or premature neonates. Such patients need detailed and extensive anesthesia pre-operative assessments and consents, which may not be feasible the morning before surgery. Our goal was to devise a system of both obtaining and retrieving anesthesia pre-operative evaluation with the use of a PDA.

### **Methods:**

A standard PDA with the Palm-OS system was used along with a generic database program. Fields were created to store patient data focusing on anesthesia related issues. The program was then modified to enable it to print an anesthesia pre-operative assessment wirelessly through the infrared port of any Hewlett Packard Printer in nursing stations throughout the hospital.

A second copy was printed and given to the anesthesiologist assigned to the case.

The assessment was then stored on a central computer in the department of anesthesiology, thereby keeping a record for future perusal if the patient returned.

### **Conclusion:**

The use of a PDA to write, print and store anesthesia pre-operative assessments is an efficient and secure alternative. It creates both paper and electronic copies, thereby easing space and time constraints. This system also makes it easier to anticipate anesthetic problems in patients that return for multiple procedures.

## THE STAIRCASE PHENOMENON: INFLUENCE OF MUSCLE SITE AND MONITORING METHOD

Stéphane Deschamps, MSc, Guillaume Trager, MSc, Pierre A. Mathieu, PhD, Thomas Hemmerling, MD, DEAA

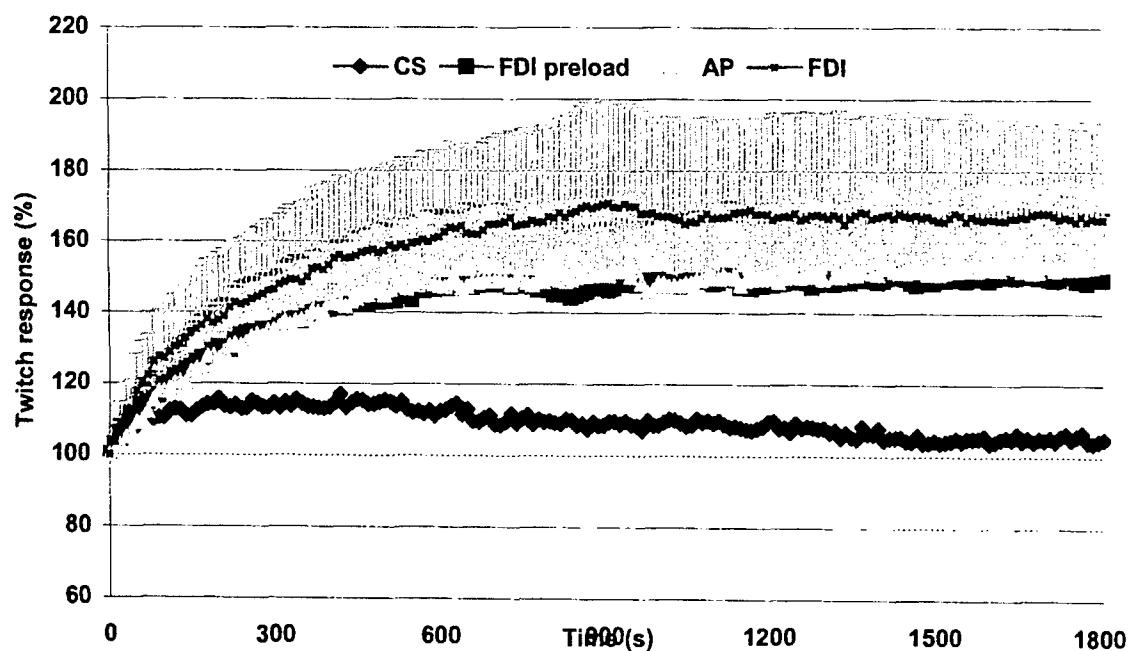
From NRG of the Dept. of Anesthesiology and the University of Montreal, Canada

**Purpose:** Phonomyography (PMG) is a novel method to monitor neuromuscular blockade. It is simple to use and can be applied to any muscle. It can be used interchangeably with mechanomyography (MMG). The staircase phenomenon has not been investigated at different muscles nor using different methods. The purpose of this work is to determine this phenomenon at two different muscles and compare two different methods.

**Methods:** In 10 patients undergoing general anesthesia using a laryngeal mask airway without aid of neuromuscular blockade, one piezo-electric microphone was applied to the corrugator supercilii muscle and both first dorsal interosseus muscles (with or without preload), each, after induction of anesthesia. In addition, MMG was applied to the adductor pollicis muscle. Supramaximal stimulation (1 Hz) was used at the ulnar nerves, a stimulation current of 20 mA at the corrugator supercilii muscle. All signals were simultaneously recorded for 30 min. Data are presented as means (SD), comparisons were made using Student *t* test or ANOVA where applicable,  $P < 0.05$ , were used.

**Results:** In all ten patients, signals were recorded. The staircase phenomenon is significantly more pronounced at the first dorsal interosseus muscle with a maximum mean increase of 37% (17%), PMG with preload, and 57% (23%), PMG without preload, as well as at the adductor pollicis muscle at 45% (16%), MMG, than at the corrugator supercilii muscle. Despite a small initial increase in mean signal height at the corrugator supercilii to a maximum of 15% (20%), there is no significant difference between the mean signal heights during the observation period. There is no significant difference in twitch potentiation between the FDI (PMG, with or without preload) and the adductor pollicis muscle (MMG).

**Conclusions:** The staircase phenomenon is more pronounced at the first dorsal interosseus muscle and adductor pollicis muscle than at the corrugator supercilii muscle.



## DEVELOPMENT OF A NEW CONTINUOUS INTRAOPERATIVE NEUROMUSCULAR MONITORING SYSTEM USING PHONOMYOGRAPHY

Guillaume Trager, MSc, Stéphane Deschamps, MSc, Pierre A. Mathieu, PhD, Thomas

Hemmerling, MD, DEAA

From the NRG of the Department of Anesthesiology and the University of Montreal,

Canada

**Objective.** Phonomyography can be used interchangeably with mechanomyography for neuromuscular monitoring during anesthesia. The purpose of this work is to develop a monitoring system based on this novel method.

**Methods.** We developed a monitoring system which can record simultaneously the neuromuscular blockade of two muscles using an interface designed using LABVIEW<sup>®</sup> software. The aim was to display signals derived from two piezo-electric microphones and to analyse these signals in real time providing trends of two muscles. The system should offer neuromuscular monitoring with or without control stimulation and simple Train-of-four-ratio (TOF) measurements. The occurrence rate of artefacts and the system reliability was tested in 10 patients undergoing general anesthesia. The workload caused by and performance of the interface was evaluated by 8 anesthesiologists using the NASA TLX<sup>®</sup>-questionnaire.

**Results.** The interface displays continuously acoustic raw signals for two different muscles. The interface is easy to use with minimal physical, mental or temporal demands permitting high user performances after minimal training. It offers the option for data recording, reviewing or data transfer. Additional features include simple artefact protection tools, such as the exclusion of electrocautery-induced artefacts by limiting the maximum amplitude recorded in the trend display. The performance of the monitoring system in relation to the time lost to artefacts was low at a mean of  $10\% \pm 2\%$  of the monitoring time.

**Conclusions.** A graphically oriented monitoring system based on phonomyography was created offering three modes of simultaneous monitoring of two muscles: monitoring with or without reference stimulation, and simple TOF-ratio measurements. The system is intuitive, resembling everyday life user interfaces, is easy-to-use and provides artefact protection tools.

# Monitoring respiration rate in PACU patients using the plethysmogram from a commercial pulse oximeter

Suzanne M. Wendelken\*, Stephen P. Linder\*\*, George T. Blike\*\*\*, Susan P. McGrath\*

\*Dartmouth College, Thayer School of Engineering, Hanover, NH

\*\*Dartmouth College, Department of Computer Science, Hanover, NH

\*\*\*Dartmouth Hitchcock Medical Center, Department of Anesthesiology, Hanover, NH

**Introduction** Post-operative patients with undiagnosed obstructive sleep apnea are at risk of sudden respiratory failure after receiving anesthesia because of repressed respiratory and hemodynamic responses [1]. While all patients have their oxygen saturation monitored in the Post Anesthesia Care Unit (PACU), few have their respiration rate monitored. The respiratory rate could be used to detect a breathing problem significantly faster than using oxygen saturation alone [8]. The goal of our study is to develop algorithms that reliably estimate the respiration rate from the pleth waveform collected by a standard, off-the-shelf pulse oximeter.

The photoplethysmogram (PPG) measured by the pulse oximeter, commonly referred to as the "pleth waveform", is an indirect measurement of blood volume under the sensor [7]. The temporal behavior of this signal is influenced both by the cardiac and respiratory cycles. Respiratory induced variations (RIV) in PPG amplitude have been documented and associated with airway obstruction, hypovolemia, and hypotension [4,5,6]. Many of these studies were qualitative and relied on analysis of baseline variations (DC component) of the PPG from a specialized pulse oximeter using a printout of the waveform.

Our algorithm extracts pulse morphology parameters from the PPG using a mixed-state feature extractor based on

previous work on sequential state estimation [3]. This feature extractor allows us to obtain statistics about each individual pulse, including pulse height, width, area, rise and fall time. Our experimental results demonstrate that these features show measurable variations due to respiration, and can provide a reliable measure of respiration rate.

**Experimental Procedure** With IRB approval, six patients (ASA Class 1 and 2) were monitored for up to an hour during their stay in the PACU. The patients were monitored using a Datex-Ohmeda® bedside monitor, a Nonin® forehead reflectance pulse oximeter, and a digital video recorder. The respiration rate was manually extracted from the video recording by observing the rise and fall of the chest.

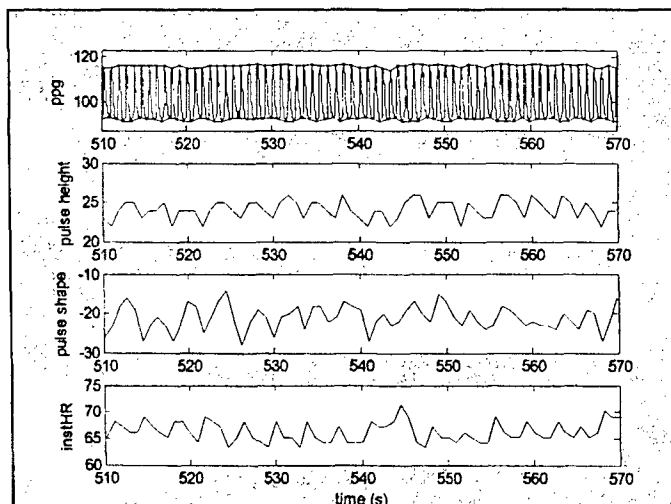
We chose the forehead location because other studies suggest that this is the best location for detecting respiratory variations in the PPG [2]. Data from the pulse oximeter was pre-processed using standard Nonin hardware (AC coupled and bandpass filtered).

**Results** The respiratory rates obtained from our feature extraction software were compared to the respiratory rates from the video. As shown in Figure 1, the pulse height, the difference between the rise and fall time and the instantaneous heart rate all provide robust statistics for estimating instantaneous respiration rate. However, during brief periods of movement, talking, or change in pose, motion artifacts obscure the pulsatile component of the signal. Also, periods of low perfusion gives a small pulse amplitude, less than ten units, and results in immeasurable RIV. Very shallow breathing can also result in very small RIV, which, along with a low or falling oxygen saturation could serve as a marker of respiratory distress. Subsequent work in our laboratory has shown that when excessive pressure is used to hold the pulse ox to the forehead the PPG is suppressed and will result in a immeasurable RIV.

**Conclusion** Respiration rate can reliably be estimated from the PPG signal of a properly mounted Nonin® pulse oximeter with limitations. We expect future version of our algorithm to fuse respiration rate calculations from all RIV signals and give a confidence interval for the respiration rate measurements based on the signal quality.

## References

- [1] Gupta R, et al, *Mayo Clin. Proc.*, 2001;76: 897-905.
- [2] Jablonka DH, et al, *Anesthesiology*, 2004;101: A191.
- [3] Linder, S. C. Shell, et al, *Proc. IEEE*, 2004;92:3.
- [4] Partridge BL, *J. Clin. Monit.*, 1987; 3(4) 263-8.
- [5] Shamir M, et al. *BJA*, 1999; 82(2):171-81.
- [6] Shelley K, et al, *Anesthesiology* 1999; 91(3A):A583.
- [7] Shelley, K., and S. Shelley. *Clin Monit: Practical applications for anesthesia and critical care*, 2001; 420-28.
- [8] Westenskow, D., et al, *Anesthesiology* 2001;95: A531.



**Figure 1.** Respiratory induced variations in the plethysmogram for a one minute time segment are shown to occur in the waveform envelope, pulse height, pulse shape ( the difference between the pulse rise and fall time) and the instantaneous heart rate calculation in beats per minute (bpm). Analysis of chest motion from the record video shows an average of 17 breaths per minute during this period. Our feature detection software found 17 RIVs for three of the four features.

# STA PROGRAM NOTES

# STA PROGRAM NOTES

# STA PROGRAM NOTES



# 5<sup>th</sup> Annual International Meeting on Medical Simulation

## January 13-16 2005 Radisson Miami FL

Any changes in the schedule will be announced from the podium and posted on the bulletin board.

### Thursday, January 13, 2005

4:00 – 6:00 pm Meeting of Society for Medical Simulation Elected Board of Overseers  
7:00 pm Welcome Reception in Technology Showcase area

### Location

Metronome  
Concerto A-C

### Friday, January 14, 2005

7:00 – 8:00 Continental Breakfast in Technology Showcase Area

8:00 – 8:15 Opening Remarks: Jeff Feldman, MD, President, Society for Technology in Anesthesia and  
Daniel Raemer, PhD, President, Society for Medical Simulation

Concerto A-C  
Symphony I & II

8:15 – 9:30 Joint Session with STA Annual Meeting

*Socio Technical Simulation & Care Process Transformation: Paul Uhlig, MD MPA*

**Technology Showcase: Posters and Demonstrations**

**General Session I: Keynote Education Address**

*Refocusing the Role of Simulation in Medical Education: Training Reflective Practitioners:*

Lindsey Henson, MD, PhD

Concerto A-C  
Symphony I

**General Session II**

*Bridge between Education & Technology: Steve Dawson, MD*

*Simulation-Based Medical Education – Innovative Applications, Trends and Future*

*Challenges: Amati Ziv, MD*

Symphony I

**SMS Annual Meeting and Luncheon**

Symphony III

12:00 – 1:30

11:00 – 12:00

9:30 – 10:00

10:00 – 10:50



1:30 – 3:00 Concurrent sessions	<p><b>General Session III</b>  <i>Panel: Pediatrics, Neonatal, OB</i>  Lou Halamek, MD, Roxanne Gardner, MD, Elaine Meyer, PhD, Toni Walzer, MD, Peter Weinstock, MD, Mary Patterson, MD, Kay Daniels, MD, Allison Murphy, MD, Kim Yeager, RN</p> <p><b>General Session IV</b>  <i>Panel: Evaluation &amp; Assessment</i>  <i>Practical Performance Assessment:</i> David Murray MD  <i>Assessing Physician Competence:</i> Jack Boulet, PhD  <i>Simulation at the Board Exam Level:</i> Haim Berkenstadt, MD</p>	<p>Session III – Symphony I</p> <p>Session IV – Symphony II</p>
3:00 – 3:15 3:15 – 4:15 3:15 – 4:15 4:30 – 5:00 4:30 – 5:30 5:00 – 6:15 7:00 – 7:30 7:30 – 11:00	<p>Technology Showcase; Posters and Demonstrations  Workshop Series I - select one of four  Roundtable: Education Research Jim Gordon, MD, MPA  Technology Showcase; Posters and Demonstrations  Roundtable: Research Funding Opportunities:  Workshop Series II - select one of four  The Great Gathering  Changes in Attitude – Changes in Latitude – a Jimmy Buffett Evening  <i>Tickets Required</i></p>	<p>Symphony II</p> <p>Metronome</p> <p>Poolside Symphony III-IV</p>

## Saturday, January 15, 2005

7:00 – 8:00

Continental Breakfast in Technology Showcase Area

8:00 – 9:30

General Session V: Teamwork

*Panel: Developing Teamwork and a Culture of Safety*

*Coordination Processes in*

*Anesthesia: Tanja Manser, PhD*

*Creating an Institutional Culture of*

*Safety through Simulation: Amitai*

*Ziv, MD*

*Medical Emergency Teams &*

*Patient Safety: Michael DeVita, MD*

*Audette, PhD*

**Research Session I:** Oral Poster Presentations and Award Presentations

**Research Session II:** Discussion at poster-side

**Box lunch**

**Roundtable: Building a Simulation Center: Lessons Learned:** Maggie Saunders & David Gaba, MD

9:30-10:30

Symphony I

10:30 – 11:30

Symphony I

11:30 – 1:00

Degas

11:30 – 1:00

Degas

1:00 – 2:30

Symphony I

Concurrent sessions

Symphony I

2:30 – 3:30

Symphony I

2:30 – 6:30

Symphony I

3:45 – 4:45

Symphony I

5:00 – 6:00

Symphony I

7:00

Symphony I

Concurrent sessions

Symphony I

Concurrent sessions

Symphony I

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Symphony I

Concurrent sessions

Symphony I

Concurrent sessions

Symphony I

Concurrent sessions

Symphony I

Concurrent sessions

Symphony I

Concurrent sessions

Symphony I

Concurrent sessions

Symphony I

General Session VI: Education

*Panel: Technology*

*Using Video Vignettes to Teach Communication Skills:*

*David Losh, MD*

*Features & Uses of High-Fidelity Medical Simulations*

*that Lead to Effective Learning: Barry Issenberg, MD*

*Towards Patient-Specific Finite Element-Based*

*Surgical Simulation: Research Issues Relating to*

*Visual, Constructive & Clinical Realism: Michelle*

*Audette, PhD*

**Research Session I:** Oral Poster Presentations and Award Presentations

**Research Session II:** Discussion at poster-side

**Box lunch**

**Roundtable: Building a Simulation Center: Lessons Learned:** Maggie Saunders & David Gaba, MD

General Session VIII

*Panel: Validation of Simulation*

*Results & Validation of a Simulation-Based Airway*

*Management Training Program: John Schaefer, MD*

*GI Endoscopy Validation: Bob Sedlack, MD*

*Future Certification for Invasive Cardiology Study:*

*David Williams, MD, ABIM*

**AIMS Working Group Meeting**

**Workshop Series III, IV, V: Select three (one per series)**

**Roundtable: Soliciting National Support for Medical Simulation:** Steve Dawson, MD

**Roundtable: Formation of a Simulation Journal:** Mike DeVita, MD

**Roundtable: Sim Center Directors:** Yue-Ming Huang, MD

7:00

Yue-Ming Huang, MD

Concurrent sessions

Yue-Ming Huang, MD

Concurrent sessions

Yue-Ming Huang, MD

Concurrent sessions

Yue-Ming Huang, MD

Concurrent sessions

Yue-Ming Huang, MD

Concurrent sessions

Yue-Ming Huang, MD

Concurrent sessions

Yue-Ming Huang, MD

Concurrent sessions

Yue-Ming Huang, MD

# Sunday, January 16, 2005

7:00 – 8:00 Continental Breakfast

## 8:00 – 9:30 Concurrent sessions

### General Session IX

Panel: Performance Assessment

Clinical Research Designs that produce

direct measures of clinical education

outcomes: Richard Kyle, MS

Measurement Issues of observed

behaviors: Rhona Flin, PhD

Tony Gallagher, PhD

### Break

9:30 – 10:00

10:00 – 11:30

### General Session XI Simulation Drivers: Where are we Headed?

How the Nursing Shortage is Driving Simulation Training:

Laurie Schumaker, RN, PhD, CCRN

FDA Requirement that Simulation be used for Carotid Stent Device Training:

Christopher Cates, MD

Serving Our Customers: Who are They Anyway? Tony Stanson, MD

Closing Remarks

Adjourn

### General Session X

Panel: Future Technology Using Full Body

Simulation: What Educators and Evaluators

Want to Know: Robert Simon, Ed.D, CPE

Bosseau Murray, MD, Gerry Moses, PhD, Steve

Dawson, MD, and Richard Satava, MD

Session IX –  
Symphony I

Session X –  
Tenor

Symphony I

## Poster Timetable

Posters Put up

Friday January 14

12:00 – 1:30 pm

Authors will be in attendance with their posters during the following times:

Friday January 14

3:00 – 3:15 pm

4:30 – 4:45 pm

Saturday, January 15

7:00 – 8:00 am

9:30 – 11:30 (poster-side

discussions, oral presentations  
& awards)

Posters Taken down

Saturday, January 15

12:30 – 3:00 pm

# 2005 International Meeting on Medical Simulation

## Faculty, Roundtables, and Workshop Presentors

**JoDee Anderson MD**  
UT Southwestern Med Center at  
Dallas  
Dallas TX

**Swati Argarwal, MD**  
Stanford University  
Palo Alto, CA

**Michelle Audette PhD**  
AIST Tsukuba Japan  
Tsukuba

**Haim Berkenstadt MD**  
Sheba Medical Center  
Ramat Gan ISRAEL

**Richard Blum, MD**  
Center for Medical Simulation  
Boston, MA

**Kristine Boyle, NNP**  
Packard Children's Hospital  
Palo Alto, CA

**Jack Boulet PhD**  
ECFMG  
Philadelphia PA

**Christopher Cates MD**  
Emory University  
Atlanta GA

**Kay Daniels MD**  
Packard Children's Hospital  
Palo Alto, CA

**Steve Dawson MD**  
Massachusetts General Hospital  
Cambridge MA

**Steve Dawson MD**  
Center for Medical Simulation  
Cambridge MA

**Michael DeVita MD**  
University of Pittsburgh  
Pittsburgh PA

**Thomas Dongilli**  
Wiser Institute  
Pittsburgh PA

**William Dunn MD**  
Mayo Graduate School of Medicine  
Rochester MN

**Martin Eason MD JD**  
ETSU  
Johnson City TN

**Walter Eppich MD**  
Yale University Hospital  
New Haven CT

**David Feinstein MD**  
Beth Israel Deaconess Medical  
Center  
Boston, MA

**Rhona Flin PhD**  
Univ of Aberdeen  
Aberdeen UK

**Frances Forrest MBBS, FRCA**  
Bristol Medical Simulation Centre  
Bristol UK

**David M. Gaba MD**  
VA Palo Alto Health Care System  
Palo Alto CA

**Tony Gallagher PhD**  
Emory University  
Atlanta GA

**Roxanne Gardner**  
Boston Children's Hospital  
Boston MA

**James Gordon MD, MPA**  
Massachusetts General Hospital  
Boston MA

**Lou Halamek MD**  
Stanford University  
Palo Alto CA

**Jordan Halasz**  
Center for Medical Simulation  
Boston, MD

**Yue-Ming Huang, MD**  
UCLA  
Los Angeles, CA

**Lindsey Henson MD, PhD**  
University of Rochester  
Rochester NY

**Marc Horowitz MD**  
University of NM  
Albuquerque NM

**Yue Ming Huang MHS**  
UCLA  
Los Angeles CA

**S. Barry Issenberg MD**  
U of Miami School of Medicine  
Miami FL

**Devin Johns BS MS**  
Gaumard Scientific Co.  
Miami FL

**Kevin King CCP(F)**  
Ontario Air Ambulance Program  
Toronto ON CANADA

**Valeriy Kozmenko MD**  
LSU Health Science  
New Orleans LA

**Richard Kyle MS**  
Uniformed Services University  
Health Sciences  
Bethesda MD

**David Losh MD**  
University WA Family Medicine  
Seattle WA

**Tanja Manser PhD**  
VA Palo Alto  
Palo Alto CA

**William McIvor, MD**  
WISER Center  
Pittsburgh, PA

**Elaine Meyer, PhD**  
Boston Children's Hospital  
Boston, MA

**Joseph Miller MD LTC**  
Andersen Simulation Center  
Olympia WA

# 2005 International Meeting on Medical Simulation

## Faculty, Roundtables, and Workshop Presentors

**Stefan Moenk MD**  
Uniklinik Mainz  
Mainz Germany

**Gerry Moses PhD**  
USArmy Medical Research &  
Materiel Command  
Ft. Detrick MD

**Bosseau Murray MD**  
The Pennsylvania State University  
Hershey PA

**Allison Murphy, MD**  
Packard Children's Hospital  
Palo Alto, CA

**David Murray MD**  
Washington University  
St. Louis MO

**Beth Olejniczak, RN BSN**  
Valparaiso University College of  
Nursing  
Valparaiso IN

**Mary Patterson MD**  
Cincinnati Children's Hospital  
Cincinnati, OH

**John Pawlowski MD, PhD**  
Beth Israel Deaconess  
Boston MA

**Jenny Rundolph, PhD**  
Center for Medical Simulation  
Boston, MA

**Richard Riley FANZCA**  
Royal Perth Hospital  
Floreath WA AUSTRALIA

**Kevin Russell MPS**  
Chelsea & Westminster Simulation  
Center  
London UK

**Richard Satava MD**  
University of Washington  
Seattle, WA

**Maggie Saunders**  
Stanford University  
Palo Alto CA

**John Schaefer MD**  
Wiser Institute  
Pittsburgh PA

**Ross Scalese, MD**  
University of Miami  
Miami, FL

**Lori Schumacher RN PhD  
CCRN**  
Medical College of Georgia  
Augusta GA

**Howard Schwid MD**  
University of Washington  
Seattle WA

**Robert Sedlack MD**  
Mayo Clinic  
Rochester MN

**Michael Seropian MD**  
Oregon Health Sciences  
Lake Oswego OR

**Robert Simon Ed.D, CPE**  
Center for Medical Simulation  
Cambridge MA

**Elizabeth Sinz MD**  
Penn State Milton Hershey Med.  
Center  
Hershey PA

**Tony Stanson MD**  
Mayo Clinic Rochester  
Rochester MN

**Chuck Stanton**  
Quillen College of Medicine  
Johnson City, TN

**Paul Uhlig MD MPA**  
Massachusetts General Hospital  
Boston MA

**Suresh Venkatan MBBS**  
Harvard Medical School  
Boston, MA

**Tony Walzer MD**  
Boston Children's Hospital  
Boston, MA

**Matt Weinger, MD**  
VA Medical Center  
San Diego, CA

**Peter Weinstock**  
Boston Children's Hospital  
Boston, MA

**Amanda Wilford, RN**  
Bristol Simulation Center  
Bristol UK

**David Williams MD**  
University of Rhode Island Medical  
School  
Providence RI

**Kim Yaeger, RN**  
Packard Children's Hospital  
Palo Alto, CA

**Steven Yule, MD**  
University of Aberdeen  
Aberdeen, Scotland

**Amitai Ziv MD**  
Israel Center for Medical  
Simulation  
Ramat Gan ISRAEL

We greatly appreciate the time and effort these faculty and presentors have made to insure a successful meeting.

All faculty are required to verbally disclose if they have or do not have any conflict of interest. If you perceive a conflict of interest that has not been so disclosed prior or during their presentation, please make not of it on your evaluation form or speak to someone at the registration desk. Thank you.

# IMMS Workshop Descriptions

## Friday 1/14

Session A 3:15 – 4:30    Session B 5:00 – 6:15

<b>Fri.</b> <b>A</b> <i>Symphony</i>	<b>Training &amp; Credentialing of Simulator Instructors</b> John Pawlowski, MD David Feinstein, MD, Robert Simon, MD, Richard Blum, MD <i>Center for Medical Simulation, Cambridge, MA</i>	As the number of whole-body simulators worldwide is growing exponentially, the need for trained instructors is also growing. This workshop will address some of the central objectives of instructor training as well as the essential traits of a proficient instructor. Using the expertise of the participants, small groups will design several educational templates to credential simulator instructors.
<b>Fri.</b> <b>A</b> <i>Degas</i>	<b>Fetal, Neonatal, Pediatric and Obstetric Simulation: How Do we Get There:</b> Lou Halamek, MD, Roxanne Gardner, MD, Elaine Meyer, PhD, Toni Walzer, MD, Peter Weinstock, MD, Mary Patterson, MD, Kay Daniels, MD, Allison Murphy, MD, Kim Yeager, RN <i>Packard Children's Hospital at Stanford, Boston Children's and Cincinnati Children's</i>	This workshop is a group interactive session regarding technology and educational issues surrounding simulation in these important areas.
<b>Fri.</b> <b>A</b> <i>Soprano</i>	<b>Static &amp; Active Scenarios – Maximizing Learning for Nurses and Jr. Doctors in the UK</b>  Frances Forrest, MD Amanda Wilford, RN <i>Bristol Simulation Center</i>	This dynamic interactive workshop will discuss and demonstrate teaching and facilitation by static and active simulation scenarios. This unique approach is based on two simulation courses "Care of the Critically Ill Patient using Simulation" or COCIP - a course that has been developed and taught to nursing staff in Bristol for the last 3 years and HELP. HELP is a one-day course with 50% of the participants nursing, 50% junior doctors and focuses on assessment, communication and teamwork and has been running for 2 years. Due to changes in the population of UK nursing, with nurses from overseas working in acute hospitals: reference will be made to the influence of culture and learning styles.
<b>Fri.</b> <b>A</b> <i>Tenor</i>	<b>Tailoring Learning Objectives for Adult Learners in Simulation of Pediatric Emergencies: One Size Does Not Fit All.</b>  Walter Eppich, PhD	This workshop will focus on educational strategies to improve the effectiveness of medical simulation training for the spectrum of pediatric care providers. One basic pediatric scenario will form the framework for our discussion. Through an interactive format we will adapt our scenario for the learning needs of professionals involved in continuing medical education. Over the course of the workshop, participants will become more versed in the instructional design process and develop skills they can transfer to their own educational activities. Participants will receive a syllabus that will offer suggested approaches to the same clinical scenario based on varied target audiences, equipping them with a set of defined simulated activities that can be readily implemented for training at their home institutions.

<b>Fri. A</b>	<b>GasMan – Basic &amp; Advanced Use for Teachers</b>	This Workshop is for current and future Gas Man® users based on experience in using the program in small group settings. This workshop will describe features
<b>Picasso</b>	Bosseau Murray, MD Len Pott, MBChB (program development) <i>Pennsylvania State University College of Medicine</i>	A. Often overlooked such as 1) Simulate multiple simultaneous agents, 2) Display picture and graph simultaneously, 3) Copy and Paste into EXCEL, 4) Understand limitation of Copy and Paste into EXCEL, 4) Understandably display and compare short wake ups after long anesthetics, B. Difficult concepts for residents to grasp 5) Basic concepts: factors influencing uptake/elimination and a quantitative grasp thereof, 6) clinical implications: overpressure and its value, and "context sensitive half-lives" of volatile agents.
<b>Workshop E</b>		
<b>Fri. B</b>	<b>Creating Effective Multiprofessional Simulational Scenarios</b>	During this interactive discussion, participants will identify specific aspects of simulation scenarios that will encourage multiprofessional interactions and will also identify higher order learning objectives that are best accomplished in a multiprofessional simulation scenario.
<b>Workshop F</b>	Beth Olejniczak, RN <i>Valparaiso University School of Nursing, IN</i> Lindsey Henson, MD PhD <i>Cleveland Clinic Lerner College of Medicine, Cleveland, OH</i>	
<b>Fri. B</b>	<b>Simulation Program Deployment</b>	In this session we will present a highly interactive discussion on the the variety of issues that must be considered when attempting to deploy a simulation education program. this program will be especially useful for thos looking to develop a program that is large in scope. Participants will be encouraged to share their experience, as obstacles are encountered solutions will be sought through a comprehensive approach
<b>Symphony Workshop G</b>	Michael Seropian, MD, <i>University of Oregon Health Sciences, Seattle, OR</i>	
<b>Fri. B Degas</b>	<b>Bedside Skills Training: Hands-on with "Harvey" the Cardiopulmonary patient simulator</b>	At the end of this workshop, participants will be able to: (1) recognize essential cardiovascular and pulmonary bedside findings, and (2) implement evidence-based learning strategies that maximize the effect of simulation-based training. "Harvey" simulates 30 cardiac conditions and is the only proven self-learning system to master cardiac bedside skills that are transferable to live patients. This presentation will be carried out in an interactive, patient-centered format. Following a focused history, bedside findings will be shared through video projection and stethophones, including blood pressure, breathing, venous, arterial and precordial impulses and auscultation. The presentation will also incorporate evidence-based strategies that lead to most effective learning.
<b>Workshop H</b>	Barry Issenberg, MD Ross J. Scalese, M.D. <i>University of Miami, Miami, FL</i>	

**Fri.  
B**

Soprano

**The Trauma Disaster Kit  
(TDCK)**

Mark Horowitz, MD  
David Wilks, MD

Workshop I

*University of NM Health  
Sciences*

The TDCK is not a commonly used feature of the HPS but is capable of increasing reality of simulations through the simulation of bleeding or secretions. The participant will be introduced to the equipment and use of this modality.

**Fri.  
B**

Tenor

**Debriefing Scenarios that  
Provoke the "Two  
Challenge Rule"**

Workshop  
J

Daniel Raemer, PhD  
Robert Simon, Ph.D., Jenny  
Rudolph, Ph.D., John  
Pawlowski, MD, Richard Blum,  
MD, and David Feinstein, MD

*Center for Medical Simulation,  
Boston, MA*

Many simulation scenarios provoke a discussion of what to do when one disagrees with the actions of a colleague, peer, mentor, or teammember. This workshop will introduce some concepts that can be introduced into debriefings to help guide the discussion of this issue. Specific scenarios where "challenge" can be provoked will be described.



# Saturday 1/15

Session A 2:30 – 3:45   Session B 4:00 – 5:15   Session C 5:30 – 6:45

**Sat.**  
**A**  
Symphony  
**Workshop**  
**K**

Observing and Measuring Behavior – Where Angels Fear to Tread  
Rhona Flin, , PhD, Matt Weinger, MD, David Gaba, MD, Robert Simon, EdD, Tanjer Masser, PhD, Jenny Rudolph, PhD, Steven Yule, MD

A dynamic discussion and interactive workshop regarding the issues of observing and measuring behavior during simulation educational and training programs. All your questions might not be answered, but you won't fear any longer to ask them.

**Sat.**  
**A**  
Degas  
**Workshop**  
**L**

Teaching Cultural Competency Through Simulation & Training.  
John Pawlowski, MD, PhD, Roxanne Gardner, MD  
Suresh Venkatan, MBBS  
*Gilbert Program in Medical Simulation, Harvard Medical School, Boston, MA*

Minority members are heartily encouraged to participate. After a review of the problem, participants will form small groups to construct unique scenarios that portray the various issues involved in cultural competency.

**Sat.**  
**A**  
Soprano  
**Workshop**  
**M**

Construction & Use of a Cannulatable Arterial Simulator for the HPS in Anesthesia & Intensive Care Training  
Martin Eason, MD  
Chuck Stanton  
*Quillen College of Medicine, East Tennessee State University*

Currently anesthesia and intensive care simulation scenarios lack a functional arterial simulator that is integral to the training mannequins. The currently available simulators have pulses that cannot vary in intensity with the clinical situation nor can they be cannulated. Participants therefore do not have the ability to use the pulse as a clinical evaluation tool nor can they train to cannulate arteries within the context of a real time scenario. We have developed a device that when installed with the Human Patient Simulator (METI) can simulate a pulse that can vary in intensity and rate to correlate with the clinical situation. Additionally, this device can be cannulated with a commercially available arterial cannula with a resultant pulsatile "flash". This device therefore, can be used as a procedural trainer and a tool to teach inexperienced clinicians the importance of evaluating the pulse as a clinical sign. Moreover, because the intensity of the pulse can be varied by adjusting the output and resistance within the device, basic cardiovascular physiologic principles can also be taught.

**Sat.**  
**A**  
Tenor  
**Workshop**  
**N**

Everything You Didn't Know the SimMan Can Do.  
Tom Dongilli, MD  
John Schaefer, MD  
*WISER Institute, Pittsburgh, PA*

One of the major concerns with all simulator user are what to do with them and understanding all of their capabilities. One area that the simulation community lacks communication in, is understanding what others are doing with their simulators. From basic use of the manikins to advanced training. In this workshop we will explore and share the way WISER is using the Laerdal SimMan and also open the forum up to have others share their experiences.

<b>Sat. B Degas</b>  <b>Workshop O</b>	<b>Write Your Own ACLS Scenarios Using a Case Authoring Program</b>  Howard Schwid, MD University of Washington & VA Puget Sound HCS	One of the biggest hurdles in medical simulation is the difficulty involved in scenario development. Attendees will learn how finite state machines can be used to develop simulation scenarios and provide intelligent help during the simulation and intelligent debriefing after the simulation. Attendees will then use a case authoring program to develop a scenario for ACLS.
<b>SAT B Tenor</b>  <b>Workshop P</b>	<b>Using the IngMar Medical ASL 5000 Simulator for Mechanical Ventilation Training</b>  William McIvor, MD WISER Center, University of Pittsburgh, PA	During this 90-minute workshop, participants will receive hands-on experience with IngMar Medical's Active Servo Lung (ASL) 5000 Breathing Simulator. We will discuss the most effective ways to use the ASL 5000 for respiratory care instruction and training.
<b>Sat. B Symphony</b>  <b>Workshop Q</b>	<b>Producing Anatomical Models and Visualizing the Results</b>  Michel Audette, PhD. AIST, Tsukuba, Japan	This workshop will introduce some of the freely available processing tools used to produce anatomical models and visualize the results. It includes an introduction to the Montreal Neurological Institute's software, based on the MINC format for medical image volumes <a href="http://www.bic.mni.mcgill.ca/software/">http://www.bic.mni.mcgill.ca/software/</a> , and an introduction to freely available visualization software, such as the Visualization Toolkit (VTK) <a href="http://public.kitware.com/VTK/">http://public.kitware.com/VTK/</a> (with a reference to ITK <a href="http://www.itk.org/HTML/Documentation.htm">http://www.itk.org/HTML/Documentation.htm</a> ), as well as some higher-level visualization tools, such as Atamai <a href="http://www.atamai.com/">http://www.atamai.com/</a> .
<b>Sat. B Soprano</b>  <b>Workshop R</b>	<b>The Decompensating Pediatric Patient...Scared Yet?</b>  Kevin King, MD University of Texas Medical Branch at Galveston, TX	This workshop will maximize familiarity with, and learn specific tips on dealing with the pediatric simulator (technical & physiological)
<b>Sat. C Degas</b>  <b>Workshop S</b>	<b>Using Mathematical Simulations to Understand Clinical Issues: Pharmacokinetics</b>  Howard Schwid, MD University of Washington & VA Puget Sound HCS	The three compartment PK model is commonly used to describe the concentrations of intravenous anesthetic agents. However, it is difficult to find consistent parameters for the drugs we use in everyday practice. Furthermore, the effects of cardiac output, obesity and duration of drug injection are not clear from this model. In this workshop the equations and constants used in the three compartment model are first clarified and the physiologic PK model is reviewed. Then, experiments are performed with the physiologic PK model to show the effects of cardiac output, rate of drug injection and obesity on plasma drug concentration. Three compartment parameters are calculated for these simulations. Finally, the results of the simulated experiments are compared to actual clinical studies.

**Sat.  
C**

**Symphony**

**Strategies for Successful  
Debriefing**

JoDee Anderson, MD  
Allison Murphy, MD  
Swati Argarwal, MD  
Kristine Boyle, NNP,  
Kim Yaeger, RN

**Workshop  
T**

*UT Southwestern Medical  
Center at Dallas  
Stanford University*

Experts have questioned the educational methodologies used in traditional medical instruction, noting a lack of attention paid to the needs of adult learners. For adult learners, the most significant learning experiences occur in the context of real life, for example, during immersion in authentic activity via hands on training. Simulation-based training allows educators in medicine to finally address the needs of the adult learner. This high-fidelity technology however, is only as good as the instructors who teach from it. Debriefing is the most critical component of the simulation exercise. workshop will begin with an introduction to debriefing and the critical elements effective debriefings must incorporate. We are planning to use video footage from our scenarios and debriefings to demonstrate effective debriefing styles. Our panel of experts have extensive history with the "good-cop, bad-cop" approach, and we are able to address all members of the training team from different areas of expertise.

**Sat.  
C**

**Soprano**

**Workshop  
U**

**Theory & Practice of  
Developing an Effective  
Human Patient Simulation  
Curriculum for Junior  
Medical School Students**

Valeriy Kozmenko, MD  
*Louisiana State University  
Health Sciences Center*

During this workshop the participants will learn how to develop a highly interactive Human Patient Simulation curriculum. Material covers elements of cognitive psychology, methodological aspects of an effective simulation session and how to expand technical potential of Human Patient Simulator.

**Sat.  
C**

**Tenor**

**Workshop  
V**

**Obstetrics Simulation:  
Shoulder Dystocia**

Roxanne Gardener, MD  
Toni Walzer, MD  
Jordan Halasz, Dan Raemer,  
PhD  
*Center for Medical Simulation,  
Boston, MA*

We have developed a simple simulator for exercises involving vaginal births. We will demonstrate a team scenario involving shoulder dystocia and provide a debriefing model for conducting such exercises.

Local Simulation/Education Centers may be open for tours. Please check the bulletin board for times. Transportation to/from is "on your own" unless noted on the host institution's flier.

Information as of 1/6/05

# 2005 IMMS Abstracts

Abstracts were submitted in the following categories: Education, Patient Safety and Technology. Abstracts marked "Demo" are in the demonstration area.

## Education Category

- 1 **Walzer Toni**  
Center for Med Simulation  
[tbwalzer@massmed.org](mailto:tbwalzer@massmed.org)  
*Human Patient Simulation of Normal & Abnormal Vaginal Birth Pilot Program for 3rd Year Harvard Medical Students*
- 2 **Schumacher Lori**  
Medical College of Georgia  
[lschumacher@mcg.edu](mailto:lschumacher@mcg.edu)  
*The Impact of Utilizing High-Fidelity Computer Simulation on Critical Thinking Abilities & Learning Outcomes in Undergraduate Nursing Students*
- 3 **Vozenilek John**  
Evanston Northwestern Healthcare  
[vzonline@ameritech.net](mailto:vzonline@ameritech.net)  
*Inter-rater Reliability Using an Automated Response System for Scoring Simulation Sessions*
- 4 **Pawlowski John**  
Beth Israel Deaconess  
[jpawlows@bidmc.harvard.edu](mailto:jpawlows@bidmc.harvard.edu)  
*Pilot Study: Evaluation of Learning/teaching Effectiveness Using Multiple Exposures to Simulated Cardiovascular Clinical Scenarios*
- 5 **Pawlowski John**  
Beth Israel Deaconess  
[jpawlows@bidmc.harvard.edu](mailto:jpawlows@bidmc.harvard.edu)  
*Pilot Study: Evaluation of Whole-Body Simulation Used to Teach Cultural Competency to Medical Students*
- 6 **Seropian Michael**  
Oregon Health Sciences  
[seropian@ohsu.edu](mailto:seropian@ohsu.edu)  
*Statewide Simulation Deployment in Oregon - It can Be Done*
- 7 **Savoldelli Georges**  
Wilson Center for Research in  
[georges.savoldelli@utoronto.ca](mailto:georges.savoldelli@utoronto.ca)  
*The Evaluation of Patient Simulator Performance as an Adjunct to the Oral Examination for Senior Anesthesia Residents*
- 8 **Szarek John**  
Ross University School of Medicine  
[jszarek@rossmed.edu.dm](mailto:jszarek@rossmed.edu.dm)  
*Problem-based Learning Using a Human Patient Simulator and its Relation to One Model of Physician Learning*
- 9 **Lighthall, Goeff**  
Palo Alto VA Stanford  
[kharrison@stanford.edu](mailto:kharrison@stanford.edu)  
*The Use of Simulation to Train Medical Residents to be Code Team Leaders*
- 10 **Meyer Elaine**  
Children's Hospital & Harvard Medical School  
[elaine.meyer@tch.harvard.edu](mailto:elaine.meyer@tch.harvard.edu)  
*Lessons Learned from an End-of-Life Communication Simulation Model*
- 11 **Meyer Elaine**  
Children's Hospital & Harvard Medical School  
[elaine.meyer@tch.harvard.edu](mailto:elaine.meyer@tch.harvard.edu)  
*What Components of an End-of-Life Communication Simulation Program are Most Helpful to Trainees?*
- 12 **Naik Viren**  
St./ Michael's Hospital U of Toronto  
[naikv@smh.toronto.on.ca](mailto:naikv@smh.toronto.on.ca)  
*Non-Technical Skills in Anesthesia Crisis Management with Repeated Exposure to Simulation Based*

- |    |                                                                                                     |                                                                                                                                                       |
|----|-----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| 13 | <b>Brown Russell</b><br>russelljbrown@shaw.ca                                                       | <i>Simulation in the of Anesthesiologists in Canada</i>                                                                                               |
| 14 | <b>Lighthall Geoff</b><br>lighthall@stanford.edu                                                    | <i>Development of a Scoring System to Evaluate the Management of Septic Shock</i>                                                                     |
| 15 | <b>Siddall Viva</b><br>Northwestern University<br>v_siddall@northwestern.edu                        | <i>A Prospective Randomized Control Trial Focused on Simulated ACLS Support Training for Internal Medicine Residents</i>                              |
| 16 | <b>Phrampus Paul</b><br>Univ of Pittsburgh<br>phrampuspe@upmc.edu                                   | <i>Death During Simulation Training: Feedback from Trainees</i>                                                                                       |
| 17 | <b>Gelbvaks Sergio</b><br>Berkley Training Ctr in Brazil<br>sgelbvaks@uol.com.br                    | <i>Virtual Hospital &amp; Simulators: A New Trend in Health in Brazil</i>                                                                             |
| 18 | <b>Cimino Linda</b><br>St. University of NY at Stony Brook<br>linda@cimino.us                       | <i>Value of Medical Simulation for Residents with Tactual/Kinesthetic Learning Styles (and specialties?)</i>                                          |
| 19 | <b>Zonfrillo Mark</b><br>Yale University<br>mark.zonfrillo@yale.edu                                 | <i>Quantifying the Pediatric Simulation Literature: A Review of Outcomes-Bsed Research</i>                                                            |
| 20 | <b>Marks Roger</b><br>Univ of Miami/Anesthesia<br>marks@med.miami.edu                               | <i>Team Training for Medical Students - An Early Exposure to Crisis Resource Management</i>                                                           |
| 21 | <b>Sudikoff Stephanie</b><br>Brown School of Medicine<br>ssudikoff@lifespan.org                     | <i>High Fidelity Medical Simulation as an Assessment Tool for Pediatric Resident Airway Management Skills</i>                                         |
| 22 | <b>Mahoney John</b><br>Unifersity of Pittsburgh<br>School of Medicine<br>mahoney@medschool.pitt.edu | <i>Integration of Human Patient Simulation into a Comprehensive Standardized Patient OSCE</i>                                                         |
| 23 | <b>Schaefer John</b><br>University of Pittsburgh<br>Medic<br>quinlanjj@anes.upmc.edu                | <i>Functional Validity of Airway Techniques in Whole Task Human Simulation Using the Laerdal SimMan</i>                                               |
| 24 | <b>Weinstock Peter</b><br>Boston Childrens Hospital<br>peter.weinstock@tch.harvard.edu              | <i>Integration of High-Fidelity Patient Simulation into Traditional Pediatric Critical Care Curriculum: Work in Progress</i>                          |
| 25 | <b>Von Wyl Thomas</b><br>University Hospital<br>tvonwyl@uhbs.ch                                     | <i>Team Performance and Interrater Reliability in Simulated Emergency Situations</i>                                                                  |
| 26 | <b>Morgan Pamela</b><br>Sunnybrook & Womens<br>pam.morgan@utoronto.ca                               | <i>High Fidelity Simulation: Translating Theory into Practice in Undergraduate Medical</i>                                                            |
| 27 | <b>Kaminoh Yoshiroh</b><br>Hyogo College of Medicine<br>ykaminoh@hyo-med.ac.jp                      | <i>Experience with Anesthesia Case Management of Simulated Patient by HPS Promotes the Knowledge Acquisition about Anesthesia by Medical Students</i> |

- 28 **Aitchison Pamela**  
Evanston Northwestern  
Health Center  
*mkharasch@enh.org*
- 29 **Gordon James**  
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- 30 **Pardo Manuel**  
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- 31 **Nakagawa Masashi**  
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- 32 **Eppich Walter**  
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- 33 **Berkenstadt Haim**  
Sheba Medical Center  
*berken@netvision.net.il*
- 34 **Manser Tanja**  
VA Palo Alto  
*manser@stanford.edu*
- 35 **Savoldelli Georges**  
Wilson Center for Research  
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- 36 **Gillespie Sarah**  
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- 37 **Gillespie Sarah**  
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- 41 **Goodrow Mike**  
University of Louisville  
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- 42 **Tarshis Jordan**  
Sunnybrook & Womens  
College HSC  
*jordan.tarshis@sw.ca*
- Physiologic Response to the Critically Ill Simulated Patient*
- The Institute for Medical Simulation: A New Resource for Medical Educators Worldwide*
- Computerized Patient Simulation in the Preclinical Curriculum: Student Perceptions After Three Years*
- Difficult Airway Management (DAM) in Japan*
- Integration of Human Patient Simulation into a Pediatric Advanced Life Support Course for Community Practitioners*
- Feasibility of Sharing Simulation-Based Evaluation Scenarios in Anesthesiology*
- An Observation Method to Assess Coordination Processes in Anesthesia*
- Activities, Perceptions and Perceived Barriers Vary with the Level of Training*
- An Introduction to Clinical Medicine for Biomedical Engineering Students Through Simulation*
- A Novel (?) Five Day Human Patient Simulation Curriculum for Anesthesiology Residents*
- The Utilization of the Anesthesia Simulator Room at Hyogo College of Medicine after Three Years, from April 2001-March 2004.*
- Is ACLS Knowledge Valuable for Anaphylactic Shock Treatment? A simulation Study in Medical Students*
- Procedural Skills Development Using Simulated Models*
- Using Patient Simulators to Reinforce Emergency Response Training for Non-Clinical Personnel*
- Creation, Implementation and Evaluation of a Nationwide Simulator Based CME Program for Family Practice Anesthetists*

- 43 **Harter Phillip**  
Stanford University  
harter@stanford.edu  
*Comparison of Student Perceptions of Web-based Virtual Reality and HPS Simulation Training in Trauma Management*
- 44 **Pozner Charles**  
Brigham & Women's Hospital  
cpozner@partners.org  
*Simulation as an Integral Component of an Emergency Medicine Residency at Harvard*
- 45 **Johnson Ken**  
University of Utah  
kjohnson@remi.med.utah.edu  
*Exploration of Partial Task and Variable Priority Training for Anesthesia Residents to Improve Management of Adverse Respiratory Events: Preliminary Results*
- 46 **Johnson Ken**  
University of Utah  
kjohnson@remi.med.utah.edu  
*Introduction to Part Task and Variable Priority Training in First Year Anesthesia Resident : A Combined Didactic and Simulation Based Approach to Improve Management of Adverse Respiratory Events*
- 47 **Hunt Elizabeth**  
Johns Hopkins  
doctorbetsy@yahoo.com  
*Simulation of Pediatric Trauma Stabilization in NC Emergency Departments: Identification of Targets for Performance Improvement*
- 48 **Brown Darral**  
Univ of Florida  
darralb@coe.ufl.edu  
*Use of a Simulation-Based Training Program at NF/SG VA Health System to Train Residents and Nurse Practitioners in Lower Gastrointestinal Tract Endoscopy*
- 49 **LeBlanc Vicki**  
Univ of Toronto  
vicki.leblanc@utoronto.ca  
*Comparison of Simulation-Based Written and Skills Examinations in Predicting Field Performance by Paramedics*
- 50 **Rockstraw Leland**  
Drexel University CNHP  
ljr28@drexel.edu  
*The Psycho/Social Correlates of Using Simulated Clinical Practicum with Students Enrolled in a Baccalaureate Nursing Program*
- 51 **Raemer Daniel**  
Center for Medical Simulation  
draemer@partners.org  
*Simulation-based Crisis Training for Pain Management Specialists*
- 52 **Baxendale Bryn**  
Queens Medical Centre  
bryn.baxendale@qmc.nhs.uk  
*Evaluating the Use of Advanced Patient Simulation in Training for Final Year UK Medical Students in the Recognition of the Acutely Ill Patient, Immediate Management Strategies and Resuscitation Skills*
- 53 **Alinier Guillaume**  
Univ of Hertfordshire  
g.alinier@herts.ac.uk  
*Development of an Organizational Model for Critical Care Interprofessional Simulation Training*
- 67 **Avery James**  
Queens Medical Centre  
James.avery@qmc.nhs.uk  
*Acute Medicine Unit Senior Nurse Development Day: Combining dynamic advanced patient simulation scenarios and static clinical knowledge and skill-based exercises to meet training needs for senior staff*

**68**  
Demo

**Shapiro Marc**  
Brown Medical School  
[mshapiro@lifespan.org](mailto:mshapiro@lifespan.org)

*Simulation Training in Emergency Preparedness (STEP): A Statewide Weapons of Mass Destruction (WMF) Training for Hospital Personnel*

**69**  
Demo

**Wang Ernest**  
Evanston Hospital  
[ernestwangmd@yahoo.com](mailto:ernestwangmd@yahoo.com)

*Addressing the Systems-Based Practice Core Competency: A Simulation-Based Curriculum*

**70**  
Demo

**Stanley Liana**  
Children's Hospital Boston  
[liana.stanley@tech.harvard.edu](mailto:liana.stanley@tech.harvard.edu)

*Using Simulation Technology to Produce an al Video: Excellence in End-of-Life Care in the Pediatric Intensive Care Unit.*

**71**  
Demo

**Dongilli Thomas**  
Wiser Institute  
[dongta@upmc.edu](mailto:dongta@upmc.edu)

*Using Simulation Based Learning Systems to Train a Large Urban EMS Service in Difficult Airway Management*

**72**  
Demo

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*Gas Man Demonstrates Apnea Greatly Prolongs Time Available for Intubation During VIMA with Sevoflurane*

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*Trauma and Awareness*

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*Teaching Clinical Skills for Undergraduate Medical Students Through Inquiry with the Use of High Fidelity Human Patient Simulator*

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**Meurling Lisbet**  
Karolinska University Hospital

*Leadership Behavior, but Not Attitude, Changes in Response to Short Term Team Training.*

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**Wallin Carl-Johan**  
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*Assessment of Team Training Using Engagement Modes and Self Efficacy*



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| 56         | <b>Lutz John</b><br>Univ of Pittsburgh Wiser<br><i>lutzjw@upmc.edu</i>                      | <i>The Use of Simulation Information Management System (SIMS) for Data Mining of Simulation Sessions</i>            |
| 57         | <b>Wade Lenny</b><br>Northwestern University<br><i>lenwade@northwestern.edu</i>             | <i>Simulating One-Lung Ventilation: Making a Double Lumen Tube Work with the METI HPS 010 Adult Mannequin</i>       |
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*Personality and Attitudinal Influences on Team-Based Behavior in Medical Work Groups*

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*Challenges to Fidelity in Prehospital Care Research & Training*

The abstracts' authors who have indicated support or involvement from a business or industry have made the disclosures listed below.

#	Company
14	Laerdal
55	British Journal of Anesthetics & Royal College of Anaesthetics
72	GasMan, Baxter, Abbott
83	Gaumard Scientific

## Human Patient Simulation of Normal and Abnormal Vaginal Birth Pilot Program for Third Year Harvard Medical Students

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As more tertiary hospital obstetrical beds are replaced by other specialties, and normal obstetrics is directed to community hospitals, medical students in teaching hospitals have less exposure to the process of normal birth. Medical students are often last in line to be involved in the process of birth because fewer normal deliveries are occurring at teaching hospitals and they often compete with interns and residents for the opportunity to gain delivery experience and skills. It is not unusual for some third year students to have completed their labor and delivery rotation without being directly involved in a normal vaginal delivery.

The primary goal of this pilot program was to provide a realistic simulation of a vaginal delivery to students who might otherwise not have a direct, hands-on experience. Both normal and abnormal deliveries were presented, exposing medical students to clinical situations they may not encounter on a typical six-week rotation, and without any risk to patients. Eight third year Harvard Medical Students participated in this simulation at the Center for Medical Simulation, Cambridge, MA.

After being given a brief overview of simulation and the use of mannequins in obstetrics, the students were introduced to a "laboring patient". They examined the patient, listening to the heart and lungs, feeling pulses, and practiced Leopold's Maneuvers. They received a short didactic session on the stages and cardinal movements of labor, normal delivery maneuvers, and delivery of the placenta.

Thereafter, students were called upon by the nurse for assistance in the labor room where a human patient simulator was in the process of giving birth. Each student performed a vaginal delivery on the mannequin.

The delivering patient developed persistent bleeding and changing vital signs. All students were asked to assist in managing this patient's post-partum hemorrhage. Together, the students and instructors discussed issues pertinent to managing the Third Stage of Labor, checking vital signs and evaluating potential sources of bleeding. Students were shown how to check the patient for lacerations, treat uterine atony, and to examine the placenta for abnormalities.

Students viewed a shoulder dystocia instructional video and then were called into a labor room to help with a precipitous labor complicated by shoulder dystocia. Instructors coached the students as they managed the delivery, performing the maneuvers necessary to relieve the shoulder dystocia and deliver the baby.

Students were asked to complete a short evaluation at the end of the simulation-based vaginal delivery course. Post-course evaluations were uniformly positive. Sample comments include: "Wonderful way to learn"; "I forgot it was Friday evening"; and "Great combo of didactics and teaching".

## The Impact of Utilizing High-Fidelity Computer Simulation on Critical Thinking Abilities and Learning Outcomes in Undergraduate Nursing Students

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Critical thinking abilities and learning outcomes are major components of nursing education. Initial critical thinking skills are often gained while the nursing student is learning the theoretical nursing principles in the classroom and is further enhanced in the clinical setting where learned knowledge is applied. A variety of instructional strategies are utilized to facilitate learning and promote critical thinking. This study compared critical thinking abilities and learning outcomes of beginning baccalaureate undergraduate nursing students when three instructional strategies were used (classroom, simulation, and a combination of classroom and simulation).

A descriptive, quasi-experimental, pretest-posttest research design was utilized for this study that compared critical thinking abilities and learning outcomes of three groups of students utilizing three instructional strategies. A maximum of 48 nursing students completed the study. A 60-item customized HESI exam was administered as a pretest to all study participants and was used to randomize the subjects into three treatment groups. Randomization occurred through a block rank ordering technique based on the initial critical thinking scores. Using one of the three instructional strategies, each group rotated through three learning activities, which illustrated the nursing care of clients experiencing an emergent cardiovascular or respiratory event: myocardial infarction, deep vein thrombosis leading to pulmonary embolism, and shock (anaphylactic and hypovolemic). After the completion of each learning activity, critical thinking abilities and learning outcomes were measured through the administration of a 20-item customized HESI exam which served as the posttest. One-way ANOVA calculations were conducted to determine the main effects of instructional strategies on critical thinking ability and learning outcomes. If significant ( $p < 0.05$ ) effects were detected, a post hoc comparison test (Bonferroni) was employed to determine which groups were significantly different.

Results indicated that there were no significant differences between critical thinking abilities ( $p > 0.08$ ) or learning outcomes ( $p > 0.12$ ) of nursing students when classroom instruction was utilized to deliver a learning activity. Significant differences were detected between critical thinking abilities ( $p \leq 0.002$ ) and learning outcomes ( $p \leq 0.001$ ) of nursing students when simulation or a combination of classroom and simulation was utilized to deliver a learning activity.

# INTER-RATER RELIABILITY USING AN AUTOMATED RESPONSE SYSTEM FOR SCORING SIMULATION SESSIONS

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Background: Many of the high fidelity simulation centers at academic centers around the nation are devoted to medical student and resident education. A variety of tools have been used to "score" participants' performance. The marketing industry uses computer-assisted evaluations in test groups when assessing the effectiveness of advertisements or products. It was the hypothesis of the investigator that this type of real-time assessment be used for rating trainee performance during simulation exercises, resulting in a more efficient, accurate, and complete evaluation of participant performance. Inter-rater reliability using these tools is paramount for future large-scale studies using these technologies.

Methods: A panel of faculty experts has evaluated trainee recordings of high-fidelity simulated patient encounters using an automated evaluation-recording tool. Simulated patient encounters contained standardized "critical events" occurring in synchrony with the evaluation process. Multiple instantaneous "grades" or "scores" were collected at regular intervals throughout the encounter recording. The evaluator response device was used to collect the data and produce a database for statistical analysis. Analysis was performed to determine the degree of inter-rater reliability using Cronbach's alpha (0.98). Future study is proposed assess the patterns or trends within and between trainees of different levels of training. There was a high degree of agreement between the assessments by faculty raters of a particular examinee's performance on a standardized case. We further anticipate that there will be agreement between the scores of individuals of a certain level of training. Proving that faculty raters can reliably "grade" a trainee's performance is a critical first step for future study of simulation-synchronized evaluations using automated devices.

## PILOT STUDY: EVALUATION OF LEARNING/TEACHING EFFECTIVENESS USING MULTIPLE EXPOSURES TO SIMULATED CARDIOVASCULAR CLINICAL SCENARIOS

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**Introduction:** The High-fidelity Patient Simulator (METI, Sarasota, FL) provides realistic clinical scenarios and can duplicate a variety of pathophysiologic conditions. Effective teaching requires a combination of style and structured information. To evaluate the effectiveness of a simulator instructor, we graded the style and content of the instructor debriefing as well as the performance of the student in multiple scenarios.

**Methods:** Two groups of three or four third year medical school students were brought to the teaching laboratory of the Gilbert Program in Medical Simulation at Harvard Medical School. The students participated in a series of cardiovascular scenarios, each scenario lasting twenty minutes. At the end of each scenario the participants were "debriefed" on the clinical components of the scenario and asked to complete a questionnaire pertaining to specific qualities of the debriefing. Following completion of the questionnaire the students had an opportunity to discuss their answers regarding the debriefing with a professional reviewer. The reviewer then shared an anonymous summary of the student's reactions with the instructor. Scenarios were alternated and repeated and the debriefings were modified based upon the suggestions from the previous debriefing questionnaires and comments. Student performance was measured using a standard scoring system for patient management (American Society of Emergency Medicine). The debriefing effectiveness was measured using a PLUS/CHANGE T-Grid, student scoring system and a third party professional reviewer.

The scenarios were repeated until the students were determined to have adequately mastered the scenarios and the student's evaluations indicated that they felt comfortable with their performance in the scenarios.

**Data:** Results of the questionnaires were scored using paired data and group analysis for each of the sessions. Debriefing Scores were tabulated using scores generated from the PLUS/CHANGE T-Grid, student scoring system and a third party professional reviewer. The results were considered significant having achieved a p value < 0.05.

**Results:** To date, we have demonstrated that this protocol can be effectively performed, and with good subjective ratings by the students.

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## PILOT STUDY: EVALUATION OF WHOLE-BODY SIMULATION USED TO TEACH CULTURAL COMPETENCY TO MEDICAL STUDENTS

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**Introduction:** The high-fidelity patient simulator (METI, Sarasota, FL) provides realistic clinical scenarios and can duplicate the interaction between patient and health care provider. We performed several related clinical scenarios and, then introduced a different cultural overlay onto one of the scenarios. Students were asked to care for the medical needs as well as to address the cultural issues of the simulator patient.

**Methods:** Three groups of third and fourth year medical students were brought to the teaching laboratory of the Gilbert Program in Medical Simulation at the Harvard Medical School. The students participated in a series of cardiovascular scenarios, each scenario lasting 20 minutes, followed by a debriefing of 30 minutes. The final scenario comprised of one of the prior cardiovascular situations now imbedded in a "cultural circumstance". The cultural circumstances involved non-English speaking patients with ethnic or religious beliefs that greatly influenced their reactions to the medical problems. After the cultural competency scenario, the debriefing included demographic information about minority populations in the U.S. as well as cultural variations in the access, acceptance, and efficacy of health care. Both factual and subjective evaluations of the cultural experience were obtained.

**Results:** To date, we have demonstrated that this protocol can be effectively performed, and with good subjective ratings by the students.

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CULTURAL COMPETENCY ASSESMENT TOOL  
PRETEST

1. What percentage of the 2000 U.S. Census Data comprises racial/ethnic minorities?
  - a. 5 per cent
  - b. 10 per cent
  - c. 20 per cent
  - d. 30 per cent
2. Which disease does **not** show disproportionately high prevalence in the minority population of the U.S. ?
  - a. Hypertension
  - b. Diabetes mellitus
  - c. Stroke
  - d. Influenza
3. Which of the following are acceptable methods of translation for a non-English speaking patient? ( choose all that apply )
  - a. Hospital translator
  - b. Telephone translator
  - c. Family member
  - d. Hospital worker, who is fluent in the patient's language as well as English.
4. Minority patients in the U.S. are vulnerable to: ( choose all that apply )
  - a. Too little health care
  - b. Too much health care
  - c. Low quality health care
  - d. Poor health outcomes
5. Racial/ethnic disparities have been noted in all but the following:
  - a. Mental health
  - b. Maternal-child health
  - c. Occupational therapy
  - d. HIV therapy



**Title:** Statewide Simulation Deployment in Oregon – It Can Be Done

**Author:** Michael Seropian, Bonnie Driggers, Jesika Gavilanes, Glenn Brady

**Affiliation:** Associate Professor, Oregon Health and Science University

The face of healthcare education is changing rapidly, in the face of sweeping personnel shortages. Simultaneously ethical, regulatory and governmental forces are putting pressure on these systems to improve systems, reduce error and increase accountability. Simulation education has been identified by the JCAHO and the IOM as a promising methodology to at least partially address some of these issues. We will briefly describe the unique statewide efforts in Oregon to broadly implement multidisciplinary simulation education in schools, health systems and training centers using an efficient and reproducible model for simulation program development. Many institutions and health systems are looking to deploy simulation education but find scarce resources and daunting potential expenses. Equipment is under-utilized largely due to sparsely documented national large-scale implementation experience. Many institutions purchase equipment, but have little experience in simulation specialist training, faculty development and program implementation/ maintenance. In Oregon, where healthcare faces dramatic faculty and provider shortages, simulation education has been identified as a method of increasing education efficiency, while also addressing patient safety. The assumption has been made that by increasing education efficiency, it will be possible to increase education capacity and therefore output.

The model that was developed included the establishment of a statewide simulation organization. Through collaboration of key healthcare representative organizations, we successfully created a statewide coordinating body named the Oregon Simulation Alliance in November 2003. Representation included the health systems, public/private universities, allied health, nursing, community colleges, public health and the governor's office. The primary goal of the alliance was not focused on one specific program but rather the success of simulation in any venue. The group was created to be a resource to ALL healthcare sectors and not a governing body. We sought to solidify and propagate priorities of simulation program design that we felt were key to success. Some targeted factors include executive support, funding, space availability, faculty development planning, simulation specialist training, curriculum integration, and business planning<sup>1</sup>. Through consultation and education we moved decision-makers away from "buy first and plan later". The premise of this exercise was to provide a conduit for efficient transfer of knowledge to decrease time to implementation and the likelihood of duplication. It was also designed to increase the probability of success, the efficiency of implementation, and cost efficiency. Prior to this project, the only substantial simulation experience in Oregon was at Oregon Health & Science University (OHSU).

A model that allowed natural local coalitions to define the collaborations was preferred over regional centers. Alliance values revolved around defining "local" locally. The group successfully petitioned for state and federal funds totaling \$1,000,000 within its first 6 months. The allocation of dollars was divided as follows: (1) \$500,000 for equipment and (2) \$500,000 for faculty development and training. Monies were distributed through a competitive RFP process. Applying coalitions agreed to abide by the general values of the alliance and to work collaboratively with multiple sectors. Preference was given to those that produced proposals that showed multi-sectored representation, clear fiscal authority, a plan for faculty and simulation specialist development, a plan for inclusion into a statewide network, and a plan for future funding. Simultaneous to the RFP process, a team of simulation experts from OHSU conducted 18 independent site visits to provide education and preliminary consultation for next steps in developing a successful program. Implementation and utilization were staggered for different disciplines

A cornerstone to this process revolved around common goals, relationships and early involvement in multiple sectors. The intent was to establish early collaboration and the relationships necessary for sharing - while creating a statewide network of simulation education facilities, programs and the infrastructure needed to support and maintain them. Beyond scenarios and general policies and procedures, it is necessary to develop statewide trainers and simulation education experts, which is being addressed through a statewide training effort centered at OHSU. By early 2005, we expect at least 12 simulation education facilities, serving multiple disciplines and over 40 institutions. This project is a national first and looks to act as a national model for widespread, rapid and successful simulation program deployment.

1. Seropian, M. et al. (2004). An approach to simulation program development. *J Nurs Ed*, 43(4), 170-4.

## Anesthesiologists and Simulation-Based Education at the University of Toronto: Activities, Perceptions, and Perceived Barriers Vary with the Level of Training

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**Background:** Although simulation-based education has been suggested to be relevant over a wide range of levels of training and experience, barriers to its use in continuing education for anesthesiologists have not been well studied. We hypothesized that level of training may influence attitudes towards simulation-based education. This study investigated this issue at our university, which possesses two sites equipped with high-fidelity patient simulators.

**Methods:** After IRB approval, a 40-question survey investigating experiences, perceptions, motivations and perceived barriers to simulation-based education, was distributed to 154 anesthesiologists attending a departmental conference. Data were analyzed using descriptive statistics and the responses to various questions were cross-tabulated. Associations between responses to different questions were assessed using either the Pearson Chi-Square statistic or a one-way ANOVA. A  $p < 0.05$  was considered significant.

**Results:** Forty staff anesthesiologists, 22 fellows, and 27 residents, returned the questionnaire for a rate of return of 58%. Residents had experienced simulation-based education (96%) more often than staff (58%) and fellows (36%) ( $p < 0.001$  respectively). Residents had also attended more simulation sessions than staff and fellows (Mean 2.8 vs 1.05 and 1.04,  $p < 0.001$  respectively). Trainees (residents & fellows) also found simulation-based education more relevant for their training (88% vs 65%,  $p < 0.05$ ). Eighty-one % of the respondents identified at least one significant barrier that prevents or limits them from attending simulator sessions. Table 1 summarizes the type of barriers and their association with the level of training.

Perceived barrier	Staff (N=40)	Trainees (N=49)	Significance
Do not perceive any barrier (%)	10.0	26.7	$p < 0.05$
Number of perceived barriers (Mean $\pm$ SD)	$1.8 \pm 1.1$	$1.3 \pm 1.2$	NS
"Lack of free time" (%)	55.0	33.0	$p < 0.05$
"Financial consequences of missing work" (%)	17.5	0.0	$p < 0.01$
"Lack of training opportunities" (%)	22.5	38.8	NS
"Stressful/intimidating environment" (%)	25.0	22.4	NS
"Fear of educator's/peer's judgments" (%)	25.0	18.4	NS
"Fear of inaccurate reflection of clinical ability" (%)	25.0	12.2	NS
"Distance to simulation center" (%)	7.5	8.1	NS
"Other barriers" (Open ended question)	4.0	2.0	NS

**Discussion:** Anesthesiologists perceive barriers to simulation-based education. Compared with trainees, staff anesthesiologists have less experience with simulators, find it less relevant for their current training, perceive more barriers, and identify 'time' and 'financial issues' as significant barriers. These results may be used to implement targeted actions such as course design, incentives, and information strategies, which could improve access and future utilization of simulation.

PROBLEM-BASED LEARNING USING A HUMAN PATIENT SIMULATOR AND ITS RELATION TO ONE MODEL OF PHYSICIAN LEARNING. **John L. Szarek, Ph.D.** and Ian Winston, M.B.B.S B.Sc. Departments of Pharmacology and Introductory Clinical Medicine, Ross University School of Medicine, Portsmouth Campus, Commonwealth of Dominica, West Indies.

Our problem-based learning (PBL) program in the fourth semester uses a high-fidelity human patient simulator (HPS Version 6, Medical Education Technologies, Inc., Sarasota FL) to enhance students' learning in the integrated curriculum and to begin to prepare them for their first clinical rotation. Slotnick has proposed that physician learning in clinical practice follows a four-stage process: Stage 0, scanning for potential problems; Stage 1, deciding whether to take on the problem; Stage 2, learning the required skills and knowledge; and Stage 3, gaining experience (Slotnick HB, Acad Med. 1999; 74:1106-1117). The purpose of this study was to explore whether our simulator PBL program prepares medical students to learn in clinical practice according to this four-stage model.

Our simulator PBL sessions were conducted in a manner paralleling that which we used in the students' first three semesters except that the time devoted to a problem was reduced from two weeks to 2-3 days and rather than presenting the problem on paper the students encountered the problem as a lifelike patient employing their communication and physical examination skills to progress through the problem. At the end of the case the students completed a questionnaire consisting of seven open-ended questions. The specific comments made by the students were coded using themes identified in their comments and expressed as a percentage of the total number of comments (numbers in parentheses). One hundred and thirty-six students completed the questionnaire. The design of the sessions and the students' responses were then related to the four stages described by Slotnick.

Stages 0 and 1: Although the students were not given the choice of whether to take on the problem, their learning seemed to parallel that related to self-directed learning in the four-stage model. The learning issues that they generated included both specific problems (those specific to the patient) and general problems (those related to gaps in knowledge or skills) which represented 32% and 68% of the learning issues, respectively. These findings were corroborated by student comments indicating that they wanted to help the patient and the case helped them identify gaps in their knowledge (16% and 11%, respectively). In addition, students did agree that it was practical to do the learning as evidenced by comments expressed by students that the simulator PBL sessions prepared them for what to expect in the clinic (11%). Stage 2: Students used semistructured learning (that is, immediately available resources such as textbooks, faculty members, library resources) to learn what was needed for the specific problems. They applied their formal learning from their classroom content to fill gaps in their knowledge and skills and to correct any misconceptions. Stage 3: Currently, students work through only one problem in the semester but it is clear that they want to gain experience. This is supported by comments made by students regarding the desire for more cases (43%) and smaller group sizes (7%) both of which will provide more patient and hands-on experience.

We conclude that, as an instructional activity, the use of a human patient simulator in a PBL program is consistent with the four-stage model of self-directed learning. In order to allow students to progress to Stage 3, however, we will need to include more cases in the fourth semester together with smaller group sizes.

## The Use of Simulation to Train Medical Residents to be Code Team Leaders

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### Introduction

Due to recent changes in their clinical rotations to accommodate work hour requirements, several internal medicine interns felt that they had not received adequate experience in running "codes" despite the fact that they would be the code team leader on the wards once they assumed R2 status. In response to their perceived need, we developed a course using a high fidelity patient simulator to teach the core principles of managing clinically unstable patients.

### Methods

A course on the acute management of critically ill patients-Stanford Course on Active Resuscitation and Evaluation (SCARE) was offered to all first year categorical medicine residents at Stanford University Medical Center and taught through the Patient Simulation Center of Innovation at the VA Palo Alto HCS. The course consisted of a brief didactic session on the basic pathophysiological principles that underlie clinical decompensation; special attention was paid to the antecedent events that are common to patients suffering cardiac arrest. The residents were then briefly trained on airway management with special emphasis on the proper placement of the laryngeal mask airway. Three different simulations were conducted using the SimMan Human Patient Simulator (Laerdal Medical). One resident was the primary team physician for the patient with an additional resident available for assistance. A third intern played the role of the bedside nurse. Upon completion of each scenario, the residents were debriefed on technical and non technical (teamwork, communication, leadership) aspects of the crisis event. Cognitive aids were distributed to each resident prior to the simulations and in the debriefing particular attention was paid to the effective use of these cognitive aids in managing the crisis and related events. At the end of the course, the residents filled out a questionnaire evaluating the course.

### Results

Twenty residents took the course which was offered during the last month of their internship. Of 17 that completed surveys, all felt comfortable in the simulator environment. 88% (15/17) of the respondents felt that they did things that they never would have been able to practice otherwise. 94% felt that the knowledge gained in the scenarios would be helpful in their clinical practice and 94% felt the course would benefit internal medicine residents. Finally, 94% (16/17) felt the course would help them practice medicine more safely.

### Discussion

The standard model for training resident physicians has historically consisted of graduated autonomy with increasing supervision over more junior house staff. Included in this increasing responsibility is being the code team leader. Residents go from being a supervised member of the code team in June, as an intern, to the leader in July as they assume more responsibility on the ward. Generally, there is no refresher course, mentorship, or leadership training that accompanies this new responsibility. We were able to design a course that taught the principles of acute resuscitation and then allowed the residents to practice these principles and their leadership skills in various simulated scenarios. Training such as this may become increasingly more important as work hours limitations impact the manner by which young physicians are trained.

### Conclusion

A simulated environment can be used to accelerate house staff training in the principles of code team leadership. Though participants were enthusiastic about the course, further studies will be needed to determine the efficacy of such training.

## LESSONS LEARNED FROM AN END-OF-LIFE COMMUNICATION SIMULATION PROGRAM

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### Introduction

Most physicians and health care providers learn about end-of-life care through trial and error. To address this shortcoming, the Program to Enhance Relational and Communication Skills (PERCS) strives to enhance the communicative and relational competencies of physicians, nurses, and psychosocial staff using high-fidelity simulation with professional actors. The daylong program provides opportunities to practice difficult conversations in pediatric palliative care, and then to reflect on the experience during videotape review and debriefing with other trainees, multidisciplinary facilitators (medical, psychosocial, and parent), and parent-actors.

### Methods

To qualitatively evaluate the lessons learned, trainees completed a post-questionnaire that included two open-ended questions:

- *What were the main "take home points" that you are likely to remember?*
- *Please reflect on what you may have learned and what you found to be most important in the session today, and on any part of your professional and/or personal learning.*

### Results

One hundred and four trainees (mean age 34.0) including physicians (40%), nurses (43%), and psychosocial staff (17%), with varying levels of experience, completed the post-questionnaire. Trainees identified both specific communication skills that they had learned, as well as broader relational abilities that can enhance family-staff conversations under difficult and uncertain medical circumstances. In terms of communicative skills, trainees cited learning the importance of using clear, honest language, examples of which include using the term "death" and explaining "what their loved one will look like, and what they may see, hear, smell," the use of a "warning shot" which can prepare families for bad news; allowing silence; and "asking more specific questions to get at the root of [a] patient's concern." Regarding relational skills, trainees reported learning, for example, that it was vital to "be natural and real," and that, "it's alright to express regret and sorrow for patient's difficulties." Trainees came to understand that patients and their families value "warmth and comfort," as well as the use of phrases like, "we are here with you in this." Finally, trainees learned about the issues and acceptability of "allowing [one]self to feel emotion." One trainee summarized the importance of relational skills in enhancing communication by saying, "How information is imparted is often more important than what the information is."

### Conclusions

Trainees of the PERCS program reported that they had learned both specific communication skills and broader relational skills. Regarding communication skills, they learned the value of speaking honestly, allowing for silence, and individualizing their language and approach based on the family's needs and preferences. With respect to relational skills, they learned that listening, showing concern, and bringing their own humanity to bear during difficult conversations is highly valued and long-remembered by families.

## WHAT COMPONENTS OF AN END-OF-LIFE COMMUNICATION SIMULATION PROGRAM ARE MOST HELPFUL TO TRAINEES?

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### Introduction

Due to the paucity of formal training in communication skills, the Program to Enhance Relational and Communication Skills (PERCS) strives to enhance the communicative and relational competencies of physicians, nurses, and psychosocial staff. Components of the program include: high-fidelity simulation with professional actors; observation of other trainees engaged in simulation; debriefing with the learning team; and supplemental educational activities and material such as didactic presentations and handouts.

### Methods

To assess the helpfulness of particular program components, trainees were asked to complete a post-questionnaire that included rank-ordering the relative value of components and responding to the following open-ended question:

- *What were the most helpful aspects of the training program?*

### Results

One hundred and four trainees (mean age 34.0) including physicians (40%), nurses (43%), and psychosocial staff (17%), with varying levels of experience, completed the post-questionnaire. Taken together, the rank ordering of the relative value of program components and the responses to the qualitative question revealed that the following components were most helpful to trainees:

1. Direct participation in the high-fidelity simulations, including interaction with the very "realistic" actors
2. Observation of other trainees engaged in simulation and hearing other trainees discuss their real-life experiences in having difficult conversations
3. Debriefing and discussion with the learning team
4. Feedback provided by the actors in their role as proxy-patients and -parents

### Conclusion

According to the trainees, direct participation in the high-fidelity simulations was the most helpful and compelling component of the program. Next, in order of helpfulness, were vicarious learning opportunities including observation of other trainees engaged in simulation and hearing others discuss their real-life experiences in having difficult end-of-life conversations. Actor feedback was also identified as particularly valuable since it offered insight into patient and parent perspectives, and how family members were affected by their conversations with health care professionals. Didactic presentations and supplemental reading material were reported to be comparatively less helpful to trainees. In summary, our findings are consistent with the adult education literature that emphasizes the importance of experiential learning opportunities, immediate interactive feedback, and active learning.

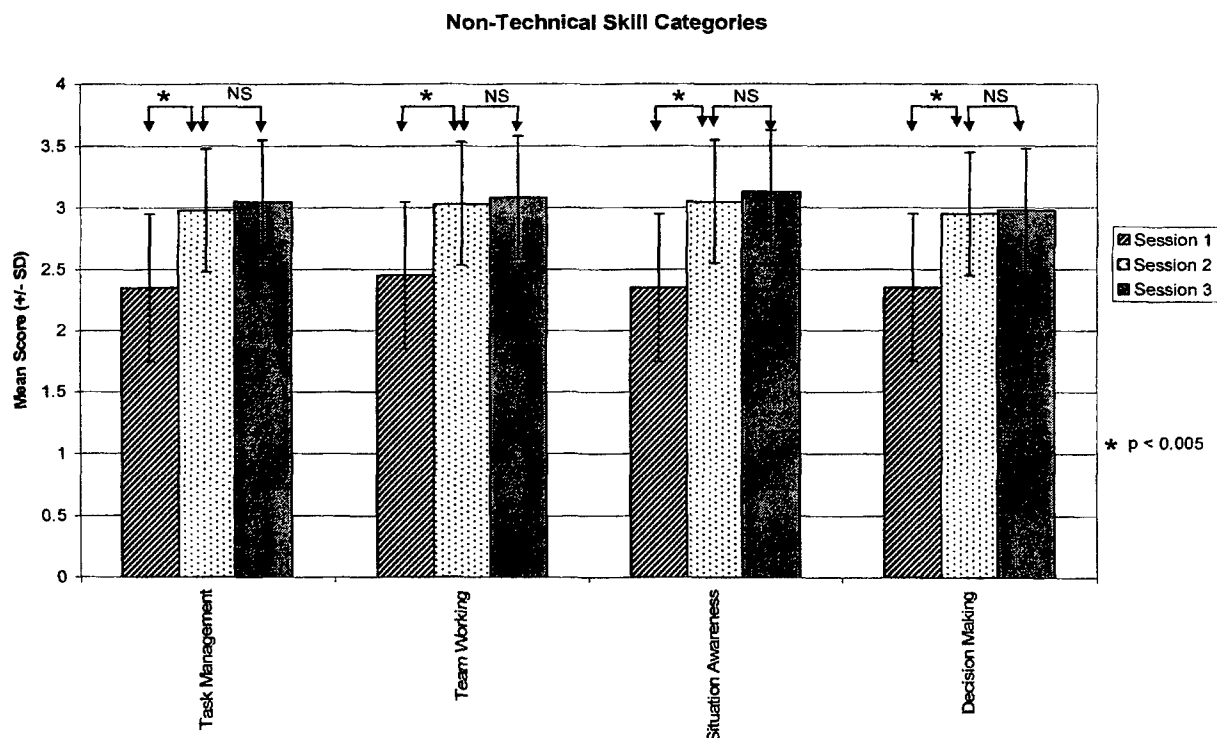
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**Introduction:** Critical incident reporting and observational studies have identified non-technical skills that are vital to successful anesthesia crisis management. Examples of such skills include task management, team working, situation awareness and decision making. These qualities are not necessarily acquired through clinical experience and may need to be specifically taught. This study uses a high fidelity patient simulator to assess the effect of repeated exposure to simulated anesthesia crises on the non-technical skills of anesthesia residents. No published studies have addressed this issue.

**Methods:** After institutional ethics approval, 20 anesthesia residents were recruited. Each resident was randomized to participate as the primary anesthesiologist in the management of three different simulated anesthesia crises using a high fidelity patient simulator. After each session, videotaped footage was used to facilitate debriefing of their non-technical skills. The videotapes were later reviewed by two expert blinded independent assessors to rate each resident's non-technical skills, using a previously validated and reliable marking system.<sup>1</sup>

**Results:** A significant improvement in the non-technical skills of residents was demonstrated from their 1<sup>st</sup> to 2<sup>nd</sup> session, and from their 1<sup>st</sup> to 3<sup>rd</sup> session (both  $p < 0.005$ ). However from their 2<sup>nd</sup> to 3<sup>rd</sup> session, no significant improvement was observed. Inter-rater reliability between assessors was good ( $r = 0.66$ ).



**Conclusion:** A single exposure to anesthesia crises using a high fidelity patient simulator can improve the non-technical skills of anesthesia residents. However, additional simulation sessions may confer little or no short term benefit.

**References:** (1) Fletcher G et al, *Br J Anaesth* 2003; 90(5): 580-8.

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**SIMULATION IN THE EDUCATION OF ANESTHESIOLOGISTS IN CANADA R.J. Brown CD MD MA FRCPC, B.T. Finucane MB BCh FRCA FRCPC, University of Alberta Hospital, Edmonton, AB**

The teaching of Crisis Resource Management (CRM) in the simulator has been ongoing at the University of Alberta since the fall of 1999. During the same period of time, The Royal College of Physicians and Surgeons of Canada (RCPSC) launched the CanMEDS initiative. This concept defined 7 specialist roles as being integral to specialists of the future. Teaching these roles is to be part of resident education and are; medical expert/decision maker, communicator, collaborator, health care advocate, manager, scholar and professional.

Traditional resident training has focussed on medical expert/decision making. However, the thrust of the CRM course bears great resemblance to the specialist roles usually ignored in resident training; communicator, collaborator, manager and professional.

In an effort to determine how CRM training can assist in educating anesthesia residents a qualitative study was undertaken to assess how residents value simulation compared to the traditional teaching venues. Following institutional and ethical review, informed consent was obtained from all the senior residents from the U of A and U of C anesthesiology programs.

In a first survey participants were asked about their real life experiences dealing with crises, first, dealing with crises in general and then about the most significant event they had been involved with. The focus was on staff-resident interaction including preplanning for emergencies, who actually managed the crisis, and debriefing which may have occurred after the problem was resolved.

A second survey looked at the learning which occurs during residency around the 7 roles from the CanMEDS 2000 initiative. It asked what residents were learning about the specialist roles in the most common educational opportunities. These opportunities are clinical work, morbidity and mortality rounds, grand rounds, anesthesia conferences, academic core days, simulator training, self-directed reading and the internal medicine year. Residents were asked to rate learning using a Likert scale which rated learning from 0 to 5 (0 = no learning, 3 = moderate learning, 5 = a great deal of learning). Focus groups followed up on the data provided by the surveys.

Data indicated that residents' experience with real critical events is less than satisfactory. The frequency of these events is unpredictable; with the average resident managing serious problems less frequently than is generally thought. Staff take over managing critical events when they occur. The actual learning resulting from managing these crises is minimal because of poor pre-planning and inadequate debriefing. Debriefing focuses on medical expertise and neglects the important leadership skills required to manage an emergency. Residents are left in the untenable position of having to make sense of these events on their own.

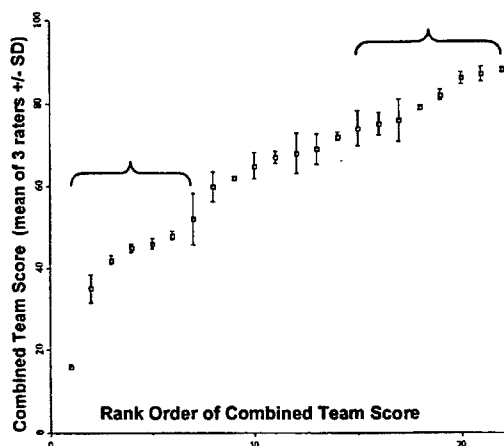
Traditional teaching opportunities do not deliver substantive learning. Learning in the simulator was rated high by participants in most roles. This data was confirmed by focus groups where participants indicated that learning in the simulator was a powerful and experiential. Simulator learning allowed for deep integration of book knowledge with practical skills, especially in the areas of communication, collaboration, teamwork and leadership.

Implications for residency programs in Canada are far reaching. In order to provide learning around all 7 Royal College roles, significant changes must occur. *Staff development* in the areas of communication, collaboration, leadership, teamwork, and teaching techniques must be given the same emphasis as scientific content at weekly rounds. *Curriculum change* must look for creative and novel ways to provide education in all the roles of the RCPSC. *Teaching methods* must change to reflect the new demands of the RCPSC. Grand rounds, mortality and morbidity rounds, and the internal medicine year can be altered to allow a more structured approach to specialist roles. *Resident evaluation* must incorporate all RCPSC roles. *Simulation use* must be strongly endorsed at an institutional and university level. Simulation can provide learning in most CanMEDS roles and should be part of every anesthesia residency program.



**Introduction:** Despite dissemination of treatment guidelines for septic shock by major critical care societies, little attention has been directed to the decision making and performance of individuals or teams managing sepsis. With our ICU house staff participating in monthly simulations of septic shock over the last three years, we have seen great variability in the quality of resuscitative efforts. Considering this, we sought to quantify the performance of teams managing septic shock in a simulated ICU through the development of two rating systems. A "technical" rating is based on consensus guidelines and principles governing the management of sepsis and shock; a "non-technical" rating is based on crew resource management (CRM) principles such as leadership, communication, contingency planning, and resource utilization. The goals of this scoring system were ease of use and consistency amongst evaluators; with such, we hoped to have a means to later explore factors that underlie good and poor resuscitative skills.

**Methods:** Monthly training sessions were conducted for participants in the adult ICU rotation (anesthesiology, surgery, and medicine) using a recreated ICU environment and a high fidelity human patient simulator. The conduct of the 35 minute sepsis scenario followed a standard design wherein interns were initially charged with the care of the patient, but other help was available. Other help consisted of a pharmacist, a respiratory therapist and an anesthesiologist who were equally blinded to the scenario. By design, senior residents and fellows joined the scenario at the 10 and 20 minute time points, respectively, even if requested earlier. Taped recordings of 22 consecutive simulator sessions were reviewed independently by three physicians who scored an array of technical (n=10) and non-technical (n=7) items on a 0-2 scale. Technical scores were generated for the interns (first 10 minutes), and for the entire group (all 35 minutes). Non-technical scores were generated for the whole group only. Scores of each session were compared to others by ANOVA. Inter-rater comparisons were made by Spearman rank correlation; p values <0.05 were considered significant in either case. For each individual score, a subjective rating of poor, medium, or good was applied based on expert opinion unrelated to the scoring system.



**Results:** The scores indicate a wide range of performances in terms of both technical and non-technical aspects of resuscitation. Scores from the upper 27<sup>th</sup> percentile were statistically distinguishable from those of the lower 27<sup>th</sup> percentile for team technical ( $p < 0.02$ ), and non-technical ratings ( $p < 0.02$ ). The upper and lower 23<sup>rd</sup> percentiles of intern scores were statistically different ( $p < 0.04$ ). Combining both technical and non-technical scores of a group provided even greater discriminatory power as demonstrated by the plot of rank-ordered mean scores, with statistically significant differences between groups of the upper and lower 30<sup>th</sup> percentiles (brackets). Construct-related validity was supported by high agreement between

subjective evaluations of each performance compared to numerical scores. Additionally, technical and non-technical ratings were highly correlated ( $r = 0.84$ ,  $p < 0.0001$ ). Inter-rater reliability was assessed by comparing the scores of the senior reviewer to the two others: (for intern scores,  $r = 0.79$  &  $0.82$ ; for residents,  $r = 0.75$  &  $0.83$ ; and for non-technical scores,  $r = 0.81$  &  $0.89$ ; for all,  $p < 0.0001$ ).

**Conclusion:** We demonstrated that a scoring system can be built around clinical guidelines for the management of septic shock, and can be used to discriminate between good and poor performances in simulations of human septic shock. Data such as this can also be used to understand factors underlying particularly weak or strong efforts, and should be used to shape teaching efforts toward maximizing effectiveness of resuscitation. Overall, we provided a model that uses simulation to test adherence to specific clinical guidelines; this methodology can be applied to any number of different disease states.

## **A Prospective Randomized Control Trial Focused on Simulated ACLS Support Training for Internal Medicine Residents**

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**Background:** Internal medicine residents must be competent to perform Advanced Cardiac Life Support (ACLS) procedures for board certification. We used a high-fidelity human patient medical simulator to assess the baseline proficiency of medical residents in ACLS skills and to determine the impact of an educational intervention on skill development compared to clinical experience alone.

**Methods:** This was a randomized trial with wait-list controls. The subjects were the 38 second-year internal medicine residents beginning in July 2003 at Northwestern University's Chicago campus internal medicine residency program. The project lasted 10 months. Each resident was tested to evaluate baseline proficiency in ACLS scenarios. Then the intervention group received four two-hour education sessions using the medical simulator. All residents were then retested after a three-month period. After crossover, the wait-list control group received the intervention and all residents were tested a third time. Performance was assessed on checklists derived from American Heart Association resuscitation guidelines for treatment of asystole, ventricular fibrillation, supraventricular tachycardia, ventricular tachycardia, symptomatic bradycardia, and pulseless electrical activity with inter-rater and internal consistency reliability estimates.

**Results:** All residents consented to participate and completed the entire protocol. The two randomly assigned resident groups did not differ at baseline on demographic or ACLS performance measured reliably. After the first educational intervention, ACLS performance was 38% higher for the treatment group compared to the wait-list control group. This result was replicated after group crossover. No improvement was detected as a function of either clinical experience or prior testing. There was no correlation between ACLS scenario performance measured by checklists and USMLE Step 1 and Step 2 scores (median correlation = -0.05). The educational program was rated highly by residents.

**Conclusions:** Training on a medical simulator dramatically increased the skills of second-year residents in leading cardiac arrest scenarios compared to clinical experience alone. Simulation-based educational programs that provide reliable performance assessments can be a valuable part of internal medicine residency training. The study design we used, a randomized trial with a wait-list control group, is well-suited to intervention studies in clinical medical education because it permits a rigorous evaluation of the effects of an educational intervention under circumstances where a large group of learners cannot be trained simultaneously.

**Objective:** To obtain feedback from trainees completing medical simulation training programs regarding their opinion on experiencing a simulated death.

**Methods:** Retrospective analysis of quality assurance surveys provided to trainees of medical simulation programs about simulated death during training courses. The training sessions occurred between April and November 2004. A total of 63 physicians and 175 non-physician Air Medical Crew (AMC) paramedics and nurses participated in simulation training during the survey period. Data was collected from either by paper form or electronically submitted forms.

**Results:** Survey data was received from 62 physicians (98%) and 162 AMC personnel (93%). Fifty-four physicians (32 residents (60%), 22 attendings (40%)) completed the survey. Thirty-three physicians (61%) reported experiencing the death of the simulator. A Likert 0 – 4 scale was used, with 0 being strongly disagree and 4 being strongly agree. Those participants that experienced a simulated death reported that they did not feel that the death impaired their learning with a median of 1 (Interquartile Range (IQR): 0-1) and reported that they believe the simulated death likely correlated to actual patient death or permanent injury with a median of 3 (IQR: 2-3).

The entire physician group agreed that they would expect the simulator to die if that was the likely outcome of the case reporting with a median of 3.5 (IQR: 3-4) and strongly disagreed that there would be a future reluctance to participate in simulation training because of a simulator death reporting with a median of 0 (IQR: 0-1). Physicians strongly disagreed with a statement stating that simulated death is inappropriate regardless of the medical management with a median of 0 (IQR: 0-1). Physicians disagreed with the statement that death during simulation should be withheld from medical student training with a median of 1 (IQR: 0-1) and disagreed with a statement that a separate disclosure of potential simulator death was needed with a median of 1 (IQR: 0-2).

One-hundred sixty-two AMC completed a similar survey. Eighty-six were nurses (53%), 67 were paramedics (43%). Six participants (4%) did not answer level of training and were excluded from the study calculations. Sixty-one air medical crew members (40%) reported experiencing simulated death. Of those, both cohorts did not feel that simulated death impaired their ability to learn. The paramedic group with a median of 0 (IQR: 0-1) and the nurse group reported with a median of 1 (IQR: 0-2). Both groups did not feel that there would have been death or permanent injury to a real patient with the paramedics with a median of 1 (IQR: 0-2.5), and nurses had a median of 1.5 (IQR: 0.75-2).

The overall AMC cohort agreed that they would have expected simulated death if that was the likely outcome of the case with the paramedic group reporting with a median of 3 (IQR: 2-4) and the nurse cohort with a median of 3 (IQR: 2-4). They strongly disagreed that there would be a future reluctance to participate in simulation training because of a simulated death, with both groups having a median of 0 (IQR: 0-1). Both AMC groups strongly disagreed with a statement that simulated death is inappropriate regardless of the medical management with a median of 0 (IQR: 0-1). AMC groups tended to agree that experiencing a case that leads to death is part of the power of simulation testing and teaching, with the paramedics with a median of 4 (IQR: 2-4), and the nurse group with a median of 3 (IQR: 2-4).

Both groups strongly disagreed that simulated death should be withheld from paramedic and nursing students reporting with a median of 0 (IQR: 0-1). Both groups disagreed with a statement that a separate disclosure of potential simulated death was needed reporting a median of 1 (IQR: 0-2). AMC members had a differing opinion to the statement that the handling of the case debriefing would be an important aspect of how they would respond to simulated death, with the paramedics median of 3 (IQR: 2-4), and nurses remaining neutral with a median of 2 (IQR: 2-4). Physicians were not asked this question.

**Conclusions:** During medical simulation training physician participants did not feel that simulated death was distracting to the learning environment. Physicians felt that medical students should not be exempt from experiencing simulated death and that a separate disclosure of the possibility was not needed. Flight paramedics and nurses did not feel that the simulated death distracted from the learning environment. They strongly disagreed that it should be withheld from paramedic and nursing students. They did not feel that experiencing simulated death would create a reluctance to participate in further simulation training. Air medical crew course participants did not feel that a separate disclaimer of the possibility of death to the simulator was needed during course orientations.

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## Virtual Hospital and Simulators: a new trend in health education in Brazil.

Sergio Gelbvaks, M.D  
Medical Manager of the Berkeley Training Center

Simulation techniques had been part of the human activity for long time. The main purpose of any simulation technique is to improve the performance, especially in front of critical (vital) events.

More recent and sophisticated simulation techniques, demands high technology and investments. This one of the reasons why simulation centers has been developed around the world, but especially in those well developed countries

The Berkeley Training Center started to use simulation techniques in Brazil, in a private manner, about three years ago, when we developed a new concept in health education, called Virtual Hospital.

The Virtual Hospital consist of using some different simulators, located at different departments ( ex: Emergency room, UTI, Coronary unit, Ultrasound Unit etc) as in a real hospital. In some courses, we develop a cenarium for as long as four days, when the student have the chance to feel and practice many skills learned in more basic courses, acting in a complex enviroment. We believe to produce in that way, a more reliable and complete situation for teaching health personel.

Value of Medical Simulation for Residents with Tactual/Kinesthetic Learning Styles (and Specialties?)

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Prior studies in education literature have demonstrated that individuals have a preferred method of learning (1). These different methods, referred to as "learning styles" can impact upon the efficiency of education. While some people may learn best from the traditional "chalk and talk" lecture format, others prefer small groups or hands-on teaching to learn the same material.

The learning styles assessment consisted of 6 sections consisting of perceptual elements, psychological elements, environmental elements, physiological elements, emotional elements and sociological elements. The familiar definitions of the five senses (seeing, hearing, smelling, tasting and touching) are expanded within the context of learning. This broader perspective focuses on the most efficient way a learner remembers new and complex material. The five preferences indicating an individual's preferred way to learn include: auditory(listening – lecture), visual picture (seeing illustrations and diagrams/algorithms), visual text (reading printed material–textbook), tactile kinesthetic (learning by doing, hands-on – medical simulation), and verbal internal kinesthetic (learning by verbalizing and making personal connections, put into own words and experiences). There were from 10 to 20 questions in each section and the assessment took about 10 to 15 minutes to complete.

Recognizing the positive impact of learning styles on resident education further validated our departmental commitment to medical simulation training. Learning Styles is an individual's preferred method for learning and retaining new and difficult information. The results from our 2003 PGY-1 resident cohort indicated that none of this group preferred to learn through auditory or visual text methods. The majority (88.9%) had a more tactual kinesthetic learning preference. In a second study, we have now assessed the preferences of our current 11 first year anesthesia residents (PGY-2004 Cohort) utilizing the same web based learning styles assessment given to last year's group. Once again, the majority was more tactile kinesthetic (90.9%) and more verbal kinesthetic (90.9%) in their learning preferences. Combining data for both groups revealed that these 20 residents were overwhelmingly strongly (90.0%) or moderately (10.0%) more tactile kinesthetic.

In summary, we believe that medical simulation will prove to be a valuable teaching modality, especially for residents (students) with a strong tactual kinesthetic learning preference.

Reference: 1) Dunn, R., et.al. J. Educational Research, 88: 353-361 (1995).

# Quantifying the Pediatric Simulation Literature: A Review of Outcomes-Based Research

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**INTRODUCTION:** Over the past decade, the use of simulation has expanded from anesthesiology circles to other areas of clinical medicine, including pediatrics. Medical simulation holds great promise to impact patient safety and improve training of pediatric healthcare providers. The purpose of this review is to quantify the outcomes-based, peer-reviewed literature pertaining to pediatric simulation and manikin-based strategies.

**METHODS:** A descriptive study using a Medline (OVID) search was performed. Citations in the pediatric simulation literature using a database from 1966 to week 3 of November 2004 were identified. Combinations of the following keywords and truncated root words were searched in the title and/or abstract: infant\$, neonat\$, newborn, pediatri\$, paediatr\$, or child\$ were matched with keywords simulated, simulator\$, simulation, mock, manikin\$, mannequin\$ or (resuscitation and education). Both investigators performed a review of all titles and available abstracts. All citations reporting outcome data for manikin or patient simulations of pediatric resuscitations and/or technical skills of healthcare providers from English language journals were included. Review articles and commentaries were excluded. The literature was evaluated with respect to year of publication, country of origin, journal type, subjects studied, and outcome measures assessed.

**RESULTS:** The search yielded 3273 citations. Of these, 47 met our criteria. Sixty percent of the citations were from institutions in the United States, 11% each from the United Kingdom and Canada, 6% from Australia, with the remainder from other countries. Sixty percent of the articles were published after 1999. Nearly sixty percent of citations originated in the pediatric and/or emergency medicine (EM) literature. Forty percent of citations focused solely on neonatal or infant resuscitation and/or skills. Only 3 citations linked manikin-based or simulation-based training data to improved clinical outcomes with actual patients. A summary of additional data analyses can be seen in the following table.

Subjects studied (N=47)	
Resident	30%
Pre-hospital providers	13%
Physician	11%
Medical student	9%
Nursing	4%
Mixed	34%

Journal Type (N= 47)	
Pediatrics	28%
EM	21%
Resuscitation	19%
Pediatric EM	9%
Anesthesia	6%
Other	17%

Outcome Measures (N=47)*	
Isolated technical skills	75%
Full mock resuscitation	34%
Attitude	17%
Assessment of systems	11%
Physical examination skills	4%

\*Total is >100% because several studies included multiple outcome measures

**CONCLUSIONS:** Even with relatively broad inclusion criteria, we have demonstrated that there is a dearth of outcomes-based pediatric simulation literature. A majority of studies originate in the United States and are published in pediatric and/or emergency medicine journals. Only a handful of studies links simulation-based educational initiatives to actual clinical outcomes. This nascent field is ripe for further study to validate simulation-based training initiatives across the spectrum of pediatric practitioners, and to document improved clinical outcomes and markers of patient safety.

**REFERENCES:** List of citations included in analysis available upon request.

## **Team training for medical students – An early exposure to Crisis Resource Management**

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### **Introduction**

High fidelity human patient simulators (HPS) are useful and important tools in medical training.<sup>1</sup> However, their routine use in medical student education is limited by lack of availability and high costs. Nevertheless, we have found that medical students prefer this method of training to formal lectures. We therefore have included HPS training as part of the standard two-week clerkship in anesthesia.

### **Method**

During the two weeks that medical students spend in anesthesia, we have scheduled them for two one-hour sessions in our simulator lab. During the first session, they are taught to perform a routine anesthetic induction and then a rapid-sequence induction. During the second session, they are presented with a case of ventricular fibrillation (VF) during general anesthesia. This scenario is followed by a debriefing session during which the students are introduced to the basic concepts of crisis resource management (CRM). A similar scenario is then run to reinforce the learning experience. The students complete an evaluation at the end of the clerkship and rate the lectures and simulation on a scale of one (low) to five (high). These assessments are then collected for routine analysis and evaluation.

### **Results**

The average score for the lectures was 4.3 (from a possible score of 5). The average score for the simulation was 4.8. Comparison of these results using a student's t-test indicated a significant difference ( $p < 0.013$ ). This indicates that the medical students prefer this method of learning to formal lectures.

### **Discussion**

The ability to deal with medical emergencies requires behavioral and managerial skills not normally included in formal medical school curriculums. We believe that team training and CRM should be introduced early in the education of physicians and other medical professionals. The medical students received our inclusion of CRM training in the simulation program very positively. Their improvement was evident not only from better completion of treatment protocols, but also by improvement in behavioral skills, especially in leadership and communication. This resulted in a positive learning experience that was reflected in the high scores received in the evaluations.

### **References**

1. Good ML. Patient simulation for training basic and advanced clinical skills. *Med Educ* 2003; 37(s1): 14-21.

## **High Fidelity Medical Simulation as an Assessment Tool for Pediatric Resident Airway Management Skills**

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High fidelity medical simulation is an evolving tool, currently used for training and, less frequently, as an assessment tool. Simulation is recommended as a method to assess ACGME competency, but there is limited pediatric literature on application of simulation for resident assessment. Having a tool to accurately assess pediatric resident competency level in acute airway management would be valuable for identifying opportunities for improvement in resident education and residency program curricula.

In order to evaluate pediatric resident competency in airway management in a high fidelity medical simulator, we performed a prospective, observational study with 13 PGY-2 pediatric residents who were PALS/APLS certified, and had no prior experience with medical simulation. Residents were given a brief intro to the simulation center, and were then required to manage two scenarios. The first scenario was a 3 month old infant with bronchiolitis, severe respiratory distress, and respiratory failure starting at 240 seconds. The second scenario was a 16 y/o with alcohol intoxication, respiratory depression, and emesis with aspiration starting at 300 seconds. We recorded time to critical actions, success rate with procedures, and harmful actions.

During the 26 scenarios, there were 37 attempts at intubation, with 16 failed attempts. Appropriate pre-oxygenation was performed in 13 of 26 cases. Rapid sequence intubation (RSI) was administered in 22 of 26 cases, although not always with the appropriate drugs. Cricoid pressure was applied in 19 of 26 cases, an end-tidal CO<sub>2</sub> detector was utilized in 13 of 26 cases, and a nasogastric tube was placed in 11 of 26 cases. Harmful actions included RSI administration prior to preparing intubation equipment, bag and mask not connected to oxygen, inappropriate endotracheal tube size, removing cuffed endotracheal tube while cuff inflated, and placing the laryngoscope blade on backwards.

Our data identified many deficiencies in pediatric resident ability to manage an acute pediatric airway situation. We feel high fidelity medical simulation could offer a formative needs assessment tool for residency program directors to use in evaluating the efficacy of their educational strategy for teaching airway management skills.



## **INTEGRATION OF PATIENT SIMULATION INTO A COMPREHENSIVE STANDARDIZED PATIENT OSCE**

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**Paul L. Rogers, MD, Donald B. Middleton, MD**  
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### **Background**

Students participate in standardized patient (SP) and patient simulation learning experiences throughout medical school curricula. These two activities are not typically integrated within a single comprehensive examination.

### **Objective**

To assess student performance on an integrated SP and patient simulator objective structured clinical examination (OSCE).

### **Methods**

134 fourth year students completed an eight station OSCE. All students had completed required 3<sup>rd</sup> year clerkships that included SP teaching and assessment exercises and patient simulator sessions. Prior to the OSCE, all students participated in at least 24 hours of patient simulator sessions during their anesthesia and internal medicine / critical care medicine clerkships and the second year clinical procedures course. Many students had additional simulation experiences during elective rotations prior to this OSCE. Seven of the OSCE stations involved SPs. One station was comprised of two patient simulator cases: a cardiac arrest requiring AED use, and a respiratory distress case that required airway management. Students were assessed on their performance of appropriate and inappropriate measures at the simulator station. Students were not briefed in advance that the exam included a patient simulator station.

### **Results**

There were generally good correlations among the SP cases, with a range of 0.56 to 0.75 using a two-tailed Pearson correlation test. Correlation between the two simulator cases and the overall history, physical and interpersonal score on the SP cases was 0.43 ( $p < 0.01$ ). Student feedback revealed that it was difficult to transition from working with a human SP to the computerized patient simulator, in spite of significant prior experience with both modalities. They indicated that being briefed before entering the room and being in familiar surroundings was insufficient to have them prepared to perform at a high level immediately upon entering the room, and that they spent the first moments of the case adjusting to working with the simulator rather than a human.

### **Conclusions**

The data suggest that the skills we measured using simulator-based examinations are different than those we measured during the SP encounters. Even with the high exposure to both types of simulation in our curriculum, students have difficulty transitioning from one modality to the other. Further investigation is warranted to discern techniques that may help students make this transition more easily, to facilitate incorporation of the highest fidelity simulation techniques into a variety of learning and assessment environments.

## Functional Validity of Airway Techniques in Whole Task Human Simulation Using the Laerdal Simman

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**Introduction:** Whole task human simulation holds great promise as a evaluation and training tool in areas such as difficult airway management. However, one of the prerequisites for proving whole task simulation to be a reliable educational instrument in difficult airway management is to demonstrate that airway techniques are performed in a functionally valid way, i.e., tools and techniques function within the simulator environment in the same way that they do in actual human patients. We hypothesized that the airway techniques suggested for use by the American Society of Anesthesiologists Difficult Airway Algorithm would be evaluated to be functionally valid in the Laerdal Simman.

**Methods:** We invited 17 physicians experienced in difficult airway management to use a variety of techniques approved for use in the American Society of Anesthesiologists Difficult Airway Algorithm in the Laerdal Simman and to rate the functional validity of those techniques compared with performing them in human patients. Participants were offered the opportunity to rate the validity of the lighted stylet, fiberoptic bronchoscope, Combitube, laryngeal mask airway, the Fasttrach intubating laryngeal mask airway, laryngeal tube, intubating stylets (bougie), Bullard laryngoscope, retrograde intubation, transtracheal jet ventilation, cricothyrotomy, and percutaneous cricothyrotomy. Participants were encouraged to rate only those techniques they felt comfortable performing in human patients in their daily practice. Participants rated individual techniques as valid or not valid. De-identified data was collected using a web-based application on a laptop computer in a fashion that blinded the authors to the decisions made by participants. Data were analyzed with the kappa statistic to determine if observed agreement was statistically different from chance. The null hypothesis (validity agreement was no greater than chance) was rejected for kappa values greater than 0.2.<sup>1</sup>

**Results:** The results are summarized in Table 1. All techniques tested were rated valid. Agreement as to functional validity of most techniques was in the very good to excellent range. The exceptions were the lighted stylet and cricothyrotomy, where agreement as to validity was substantial and good, respectively.

**Conclusions:** All airway techniques suggested within the ASA Difficult Airway Algorithm are functionally valid in the Laerdal Simman.

**References:** 1. Landis J, Koch G. The measurement of observer agreement for categorical data. *Biometrics* 1977;33:159-74.

Table 1. Validity Ratings of Individual Techniques Used in the ASA Difficult Airway Algorithm

Device	Raters	Valid	Not Valid	Kappa	Agreement
Lighted stylet	14	12	2	0.71	Substantial
Fiberoptic bronchoscope	17	16	1	0.88	Near Perfect
Combitube	16	15	1	0.88	Near Perfect
Laryngeal mask airway	17	16	1	0.88	Near Perfect
Fasttrach laryngeal mask airway	16	16	0	1.0	Perfect
Laryngeal tube	10	10	0	1.0	Perfect
Intubating stylet/bougie	15	15	0	1.0	Perfect
Bullard laryngoscope	5	5	0	1.0	Perfect
Retrograde intubation	15	14	1	0.87	Near Perfect
Transtracheal jet ventilation	15	15	0	1.0	Perfect
Cricothyrotomy	14	11	3	0.57	Good
Percutaneous cricothyrotomy	14	13	1	0.86	Near Perfect

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**Introduction:** Opportunities for independent clinical decision-making and intensive bedside teaching are becoming increasingly limited for pediatric residents due to issues that include work hour restrictions, patient safety, emerging expectations for attending-level care only and reimbursement requirements. Moreover, less time for residents and staff at the bedside has made it difficult for faculty to reliably evaluate a trainee's clinical performance and communication skills. Virtual patient encounters using high fidelity medical simulation offer to powerfully enhance pediatric skills training and assessment.

**Background:** For over ten years, the pediatric intensive care unit (MSICU) curriculum at Children's Hospital Boston has consisted of 20 one-hour lectures taught over a one-month period. More recently, mock codes have been added, held in our on-site pediatric simulation center. The center revolves around an anatomically and physiologically accurate pediatric simulator capable of automatic physiologic responses. Such an advanced mannequin makes it possible to flexibly incorporate simulation-based teaching with traditional lecture material.

**Objective:** To develop a "simulation-enhanced" pediatric critical care curriculum for teaching and assessing at all levels of patient care, including: (1) pathophysiology, (2) history and physical taking, (3) ordering and interpretation of tests, (4) diagnosis, (5) delivery of therapy, and (6) communication skills.

**Methods:** The existing curriculum was divided into seven "modules" covering all fundamental areas of pediatric critical care medicine—airway, pulmonary/ventilation, neurology, analgesia, fluid/electrolyte/nutrition, shock and sepsis/SIRS. A "phase in" approach was selected to establish proof of concept—initially, three modules would be developed and beta-tested followed by four to complete the curriculum. A curricular development team—comprised of a "clinical educator" (a physician familiar with the curricular design and well versed in simulation and medical education), a critical care fellow and the simulation program coordinator—met with core teaching faculty to assess the strengths and weaknesses of the current lecture series. Specific teaching goals were identified and assigned to either didactic, simulation, or a combination of both teaching modalities. Based on consensus, lecture materials were adjusted and simulator-based modules were designed to add value to the teaching program while minimizing disruption in the lecture schedule.

**Results:** We have successfully developed a curricular outline and plan that preserves didactics while providing illustrative enhancement via robust simulation. The curriculum has received unanimous support of a critical care faculty. Three simulation-enhanced modules (airway, pulmonary/ventilation, and neurology) are currently under development and four additional modules (analgesia, fluid/electrolyte/nutrition, shock and sepsis/SIRS) will follow. "Ultra" high-fidelity scenarios simulate actual MSICU cases and include accompanying radiographs, EEGs and echocardiograms.

**Ongoing and Future Work:** After staged introduction and testing of the simulator-enhanced curriculum, we plan to compare simulator-based teaching with traditional methods of instruction among pediatric residents. Qualitative and qualitative outcomes will be measured in residents engaged in alternating simulation-enhanced (intervention group) vs. didactic only (control group) curricula. Assessments will evaluate the subjects' ability to "think on their feet" and perform the basic parts of successful patient care. We hypothesize that pediatric simulation-based learning can promote higher-level integration of information, thereby enabling more effective learning and patient care.

## Team Performance and Interrater Reliability in Simulated Emergency Situations

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**Introduction.** Simulation of specific situations in emergency medicine is a good tool to improve knowledge without harming the patient. At the same time, simulations allow for research on the influence that teamwork, communication, hierarchy, and leadership structures have on overall performance. The aim of our work was first to show whether two independent observers were able to reliably rate medical and communicative skills during simulations, and second to determine if there was a positive correlation between these skills.

**Methods.** In this prospective study, 60 paramedics were divided into 30 teams and each team had a designated leader and member. Each team was recorded by videos and rated by two independent observers (who were always the same) while they managed one of two simulated emergency situations; a situation with a critically ill patient ( $n = 15$ ) simulated by a Laerdal Skillmaster mannequin and a situation with a severely injured patient ( $n = 15$ ) represented by a healthy patient with moulage injuries. The observed items of the team's medical performance included type, order, and time of adequate medical care. The communicative ability included leadership, information transfer and task delegation. **Statistics:** The interobserver reliability of the medical and communicative data was analyzed by intraclass correlation coefficient (ICC) and Kappa statistics. The z-standardized values of the medical and communicative data were correlated by the Pearson Correlation ( $r$ ).

**Results.** The interobserver reliability between the two raters was high for the communicative data (ICC between 0.68 and 0.90) and very high for the medical data (ICC = 0.96). The correlation of medical performance with overall communicative performance was positive and statistically significant ( $r = 0.57$ ;  $p < 0.01$ ) (Fig. 1). Analyzing the communicative subscales medical performance correlated significantly with the teamleader's communication ( $r = 0.60$ ), delegation ( $r = 0.49$ ), and leadership ( $r = 0.41$ ) as well as with optimal teamwork performance ( $r = 0.54$ ).

**Conclusions.** This study shows that medical performance and communicative aspects of simulated situations can be reliably observed and evaluated. For several items there were statistically significant positive correlations between medical performance and communicative aspects in these simulated situations. The question of whether there was good medical performance because of good communication in the team or vice versa could not be answered with this study design. However, the importance of communication in a teamwork situation could be demonstrated.

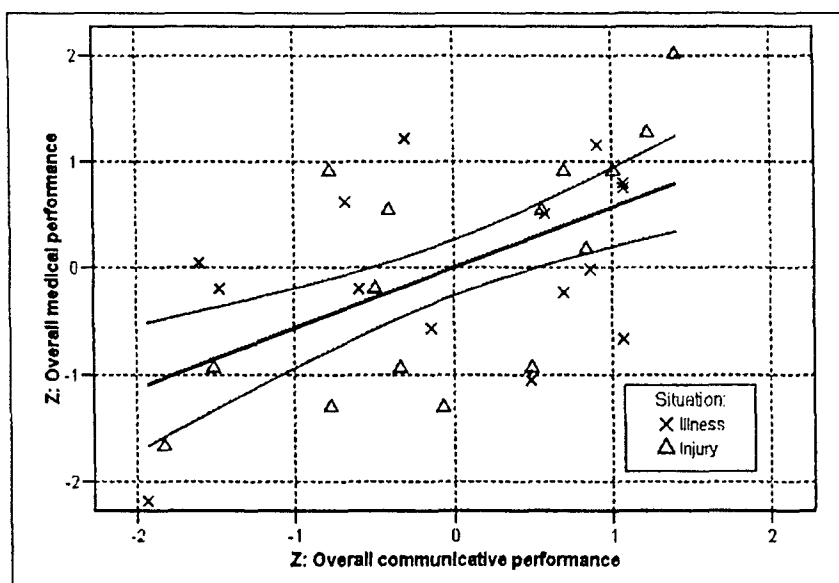


Fig. 1: Comparison of medical output and quality of communication ( $r = 0.57$ ;  $p < 0.01$ ). Each symbol represents the z-standardized value of a situation with a critically ill patient or a severely injured patient. Regression line and 95% confidence interval lines are shown.

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## INTRODUCTION

Bridging the gap between theoretical knowledge and the practical application has been problematical for most professions. Many recent innovations in medical curricula have focused on the need to integrate practice and theory and teaching students to "know how" rather than to "know all". The importance of teamwork and communication skills are now core expectations of national bodies such as the Association of Canadian Medical Colleges (ACMC) and the General Medical Council in the United Kingdom. This study was designed to allow medical student teams to manage a high-fidelity simulation case and to repeat the scenario after a faculty-facilitated debriefing and review of written educational material.

## METHODS

After research ethics board approval and informed consent, final year medical students completed a 10 question multiple choice quiz to identify their knowledge regarding the management of cardiac arrhythmias. Four simulation scenarios were presented and students worked through each scenario as a team. Faculty facilitated the sessions and feedback was given using students' videotaped performances as a template for discussion. Performance evaluation scores using predetermined checklists and global rating scales were completed. Students then reviewed the American Heart Association guidelines for the management of unstable cardiac arrhythmias. The afternoon session involved repetition of the 4 case scenarios with the same teams involved but different team leaders. Students then repeated the quiz they received in the morning. Descriptive statistics, paired t test and repeated measures analysis of variance (ANOVA) were used to analyze results.

## RESULTS

Two hundred ninety-nine students comprising 103 teams completed the study. There was a significant improvement between individual's pre and posttest pharmacology test answers,  $t=7.650$  ( $p<0.001$ ). Analyses of data indicated a significant improvement between pre and posttest simulator team performance scores when all scenarios were considered together ( $F_{1,103}=101.29$ ,  $p<0.0001$ ). Specific scenarios did have an impact on improvement in learning in that some scenarios were more difficult than others ( $F_{3,103}=15.63$ ,  $p<0.0001$ ). There was also significant improvement in checklist and global rating scores between pre and posttest performance when analyzed by scenario (Table 1)

Scenario #	Checklist Pre/Posttest	P value	Global Pre/Posttest	P value
1	$F_{1,26}=18.38$	$P<0.0001$	$F_{1,26}=22.75$	$P<0.0001$
2	$F_{1,26}=25.99$	$P<0.0001$	$F_{1,26}=20.08$	$P<0.0001$
3	$F_{1,26}=51.32$	$P<0.0001$	$F_{1,26}=34.67$	$P<0.0001$
4	$F_{1,26}=7.54$	$P=0.011$	$F_{1,26}=8.20$	$P=0.008$

## CONCLUSIONS

High-fidelity simulation is a valuable learning experience and bridges the gap between theory and practice. Further work examining communication skills and team dynamics is warranted.

## Experience with anesthesia case management including simulated patients promotes knowledge acquisition about anesthesia by medical students.

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Simulators are useful in order to teach the novice trainee about the procedures and skills of standard patient care. However, the efficacy of simulator training is often difficult to prove. In this study, we examine the beneficial effects of HPS (Human Patient Simulator, METI, Sarasota, Fl, USA) on knowledge acquisition by medical students about anesthesia.

**Method:** 47 medical students were divided into 9 groups; each group consisted of five or six students. Each group experienced clinical practice for 7 working days in Hyogo College of Medicine Hospital. The training included lectures, simulator sessions, and observations of clinical procedure in the operating room, the pain clinic, and the intensive care unit. Each group was divided into two small groups (2 or 3 students in each small group). One of the small groups experienced the standard anesthesia management of the simulated patient by HPS on the 5th day (Group-A), and the other group on the 6th day (Group-B). The students took a quiz three times; at the beginning and the end of the training, and on the morning of the 6th day. Therefore, one of small groups took the quiz after the simulator session (Group-A), and the other small group took it before the simulator session (Group-B). 200 questions (with "yes" / "no" answers) about anesthesia were pooled, and each quiz consisted of 10 questions randomly chosen from them. Statistical comparisons were carried out using a student *t* test. A probability of error of  $p < 0.05$  was considered significant.

**Results:** Table shows the scores. In Group-A, the score significantly increased on the 6th day (after the simulator session) compared to the beginning of the training. In Group-B, the score did not increase on the 6th day (before the simulator session) compared to the beginning, but it increased at the end of training period. The score of Group-A was significantly higher than that of Group-B on the 6th day.

**Conclusion:** The experience with anesthesia case management using a simulated patient by HPS promotes the acquisition of anesthesia knowledge by medical students.

	Group-A	Group-B	Group A vs. B
At the beginning	6.23 ± 1.39 (26)	6.29 ± 1.23 (21)	NS
On the 6th day	¶7.00 ± 1.36 (26)	6.05 ± 1.85 (20)	$p < 0.05$
At the end	¶7.17 ± 1.99 (23)	¶7.00 ± 1.60 (19)	NS

Mean ± SD (n)

¶:  $p < 0.05$  compared to pre-simulation score

**Physiologic Response to the Critically ILL Simulated Patient**

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Patient simulation has become a significant modality in the teaching of pre-hospital and medical resident education. Clearly, the simulator lab is a tremendous tool in teaching physicians without the significant stakes that exist in real beside management of patients. Little is known about the physiologic effect of simulation on trainees. Prior studies have suggested that in the real clinical setting, where a patient's life is affected by split second decisions, a significant rise in blood pressure and heart rate of the treating physician is expected.

We propose to investigate the physiologic response of heart rate and blood pressure when a physician is simulating the treatment of a critical ill simulated patient. A Holter monitor is placed on the treating physician and a baseline heart rate and blood pressure is measured. The physician is then presented with a case of anaphylaxis that requires complex airway management, significant hypotension and arrhythmias, and treatment for a pneumothorax. The heart, rate both mean and maximum, and blood pressure is measured during this ten to fifteen minute critical case management period. A heart rate and blood pressure immediately after the case is completed and recorded.

The trainees are in the lab for educational purposes and are not graded nor do they have evaluations based on their performance.

This pilot study has shown significant variability in baseline and case management heart rates and blood pressures of trainees. A more formal study including medical students and first through fourth year emergency medicine residents is currently in progress to evaluate changes in physiologic response based on their level of training. We anticipate that pooled data from multiple participants from different levels of training may give a more accurate picture of the physiologic stress response of trainees during critical care high fidelity simulation sessions.

## THE INSTITUTE FOR MEDICAL SIMULATION: A NEW RESOURCE FOR MEDICAL EDUCATORS WORLDWIDE

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Simulation is emerging as an important approach to safe and reliable education and experiential training in medicine. The Harvard-MIT community has played a leading role in piloting and developing the use of high-fidelity patient simulators—computer-controlled mannequins used in realistic settings to replicate clinical encounters with high fidelity.

**Purpose:** As an extension of a project funded by the Josiah Macy, Jr. Foundation, our educational development team based at the Center for Medical Simulation (CMS) explored the conditions required to propagate medical simulation as an educational field. While the use of simulation was expanding around the world, there were no unified educational standards, limited academic leadership in the field, no programs for rigorous training and education, and no formal avenue for “mentorship” in the field. To address these challenges, the Harvard-MIT Division of Health Sciences and Technology and CMS conceived of the Institute for Medical Simulation, dedicated to helping centers across the world develop high-quality programs in simulator-based medical education and research. Here we describe the development and inaugural offerings of the Institute.

**Methods:** Beginning in 2003, we performed an educational needs assessment based on inquiries and surveys in the local medical community. That information was the basis for developing 1-2 day educational modules, which were then piloted among local educators in 2003-4. Course themes included teaching and debriefing; center operations and administration; educational leadership; and performance evaluation and research. Based on feedback and consensus review, these pilot modules were remolded into a weeklong Comprehensive Workshop in Medical Simulation open to the public. The Institute’s inaugural offering of the Comprehensive Workshop was held June 7-12, 2004 at CMS.

**Results:** Over 150 faculty participated in the pilot modules, for which the average course evaluation rating was 4.61 (n=12 courses, Likert scale: 1[poor]—5 [outstanding]). The two initial Comprehensive Workshops had international representation (30 participants) and an overall average course rating of 4.71. The Workshop and shorter modules on special topics (teaching, research, leadership) are now being offered several times throughout each year.

**Conclusion:** Based on expertise developed within the Harvard-MIT community, the Institute for Medical Simulation has emerged as an international resource for educators in the growing field of medical simulation.

*This work was supported in part by funding from the Josiah Macy, Jr. Foundation and The Risk Management Foundation of the Harvard Medical Institutions. For more information please contact Jim Gordon ([jgordon3@partners.org](mailto:jgordon3@partners.org)) or Robert Simon ([rsimon@harvardmedsim.org](mailto:rsimon@harvardmedsim.org)); applications and information on Institute offerings can be found at [www.harvardmedsim.org](http://www.harvardmedsim.org).*



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#### BACKGROUND:

Computerized patient simulation is a new educational method in medical student education. At UCSF we developed curriculum modules using simulation beginning in the year 2000. The preclinical curriculum (called the "essential core") was redesigned and implemented in Fall 2001. Several simulation-based course modules have been incorporated as part of the required small group exercises. This abstract reviews student perceptions of these experiences.

#### METHODS:

Beginning in Fall 2001, first year students have participated in three simulation-based course modules. The main themes include acute care patient evaluation, assessment of hypotension, assessment of acute dyspnea, and applied pharmacology of anesthetic drugs. The structure of these courses was the same: a one-hour small group exercise divided into two sections. In groups of nine, the students assessed and treated a simulated patient for 30 minutes then discussed the relevant learning issues in a 30-minute discussion. The small group leaders consisted of faculty and specially trained fourth year medical students. At the end of each course, students filled out a brief course evaluation, which included an overall course rating and open-ended queries including "what I liked about the course" and "what I would change about the course".

#### RESULTS:

We received course evaluations from almost all participating students. The following table shows the curriculum block, number of evaluations received (N) and the overall course rating (5-point Likert scale with 1=poor, 5=excellent) of each course, organized by year.

Organs CV	2001	2002	2003	Organs Pulm	2002	2003	2004
N	139	142	142	N	133	125	140
Overall	4.76	4.71	4.75	Overall	4.77	4.64	4.45
BMB	2002	2003					
N	135	123					
Overall	4.34	4.33					

Of the 1079 total evaluations received, we analyzed the nature of the free text comments to the queries "what I liked about the course" (512 non-blank responses) and "what I would change about the course" (442 non-blank responses). Common answer themes and number of times mentioned for the query "what I liked about the course" included "real" or "realistic" (91), "interactive" (48), and "integration" (30). For the query "what I would change about the course", themes included "smaller groups" (85), and "nothing" (21).

#### CONCLUSION:

A small group exercise featuring a computerized patient simulator can be used to supplement other learning modalities in the preclinical medical school curriculum. This educational method can be used to provide a reproducible, realistic, interactive, and integrative learning environment.

## Difficult Airway Management (DAM) Workshop in JAPAN

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All authors are board members of Japanese Society of Difficult Airway management.

Difficult Airway Management (DAM) is one of the hot issues in anesthesia practice, but a practical course of DAM has never existed in Japan. We held DAM workshops at the 51st annual meeting of Japan Society of Anesthesiologists (JSA51, May 2004, Nagoya, Japan) and the 24th annual meeting of Japan Society for Clinical Anesthesia (JSCA24, October 2004, Osaka, Japan). We also established the organization for DAM workshops, named Japanese Society of Difficult Airway Management (JSDAM). We introduce the DAM workshop of JSDAM in this presentation.

**DAM workshop:** The DAM workshop consisted of a 60-minute lecture about the ASA difficult airway management algorithm, and a 120-minute hands-on training session using a mid-fidelity human simulator. We held the lecture 3 times at JSA51 and JSCA24, and the member of societies can attend a lecture freely without pre-registration. Three hands-on training sessions were held at each meeting and each training session was limited to 8 or 9 participants who registered in advance. The participants of the hands-on training session were required to attend the lecture beforehand. The training session was restricted to only participants and staff to ensure the privacy of participants. The instructors of the DAM workshop were board-certified anesthesiologists of JSA and completed the DAM course of Peter M. Winter Institute of Simulation, Education, and Research (WISER, University of Pittsburgh).

**Participants of DAM workshop:** There were more than 100 participants in each lecture and 48 participants completed the hand-on training session. 42 participants among 48 answered the questions about their experience as anesthesiologists and their competency. They had an average of 8.5 years experience as an anesthesiologist, and 26 participants had more than five years experience. 21 participants (50%) were board-certified anesthesiologists.

**Questionnaire about DAM:** The questionnaire about DAM was collected after the lectures and the training sessions. Most of the participants of lectures were certified anesthesiologists, and they agreed that the DAM workshop was useful. The questionnaire revealed that the most popular technique for DAM was the intubating laryngeal mask and few anesthesiologists experienced the invasive techniques in the clinical practice. Those who participated in the hands-on training session gained more confidence in handling the difficult airway cases than those who attended only the lecture (table). We suspected that the DAM workshop was invaluable, especially in training the use of invasive techniques without relying on substitute training methods under clinical situation.

**Future activity of JSDAM:** We will have the DAM workshop at JSA52 (June 2005, Kobe Japan) and JSCA25 (October 2005, Osaka, Japan). We are also planning to have the seminar twice a year independently by JSDAM.

Table. Did you gain confidence to handle the DAM cases after finishing this seminar?

	Did you get confidence in DAM?			Sum
	Yes	Even	No	
Lecture only	25 (15.2%)	122 (74.4%)	17 (10.4%)	164 (100%)
Hands-on session	24 (54.5%)*	20 (45.5%)	0 (0.0%)	44 (100%)
Sum	49 (23.6%)	142 (68.3%)	17 (8.2%)	208 (100%)

\*:  $p < 0.001$

# Integration of Human Patient Simulation into a Pediatric Advanced Life Support Course for Community Practitioners

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**Introduction:** A well-established tool in the fields of anesthesiology and emergency medicine, human patient simulation (HPS) is also becoming more widespread for pediatric training at academic centers. While it has been demonstrated that medical students and residents appreciate simulation-based training, it is unclear whether experienced community practitioners would similarly find HPS of benefit for their learning.

**Methods:** Simulations of pediatric emergencies were incorporated into a Pediatric Advanced Life Support (PALS) course designed for advanced community practitioners. Multiple simulation sessions (Table 1) were interspersed between traditional didactic lectures and task-oriented stations. At the conclusion of the course, all participants were given an evaluation form specifically focused on the simulation component. In addition to background information about profession (MD, PA, APRN), specialty, and years in practice, participants responded to questions about their attitudes surrounding HPS (Likert scale format with scores 1 to 5; 5 = highest level of agreement) and were able to offer free-text comments.

Table 1 Simulation scenarios

- Upper airway obstruction secondary to foreign body aspiration
- Respiratory failure secondary to pneumonia
- Hypovolemic shock secondary to dehydration
- Anaphylaxis with respiratory and circulatory involvement
- Septic shock/respiratory failure in a patient with fever and neutropenia

**Results:** Fifteen of 18 participants (83%) completed the evaluation form. Twelve were pediatricians; two were advanced practice nurses, and one a physician associate. Mean years in practice was  $12.8 \pm 10.3$ , with a median of 18 years and a range of 1 to 33 years. Participants' evaluations are summarized in Table 2. Free-text comments highlighted the realism and interactive nature of HPS. Participants noted that HPS allowed them to assess their own level of emergency preparedness, provided prompt feedback about their performance, and promoted critical thinking skills.

Table 2 Summary of Human Patient Simulation Evaluation

	(Mean score on Likert scale 1-5)	Percent agreement with statements
Effectively represents reality	$4.33 \pm 0.49$	67% somewhat, 33% very effective
Effectiveness as a tool for learning skills	$4.40 \pm 0.83$	40% somewhat, 53% very effective
Effectively stimulates critical thinking	$4.53 \pm 0.64$	33% somewhat, 60% very effective
More effective than didactic lectures	$4.13 \pm 0.64$	60% more, 27% much more effective
Scenarios sufficiently realistic/complex	$4.67 \pm 0.49$	33% agree, 67% agree strongly
Value of facilitator feedback	$4.67 \pm 0.49$	33% agree, 67% agree strongly
Overall rating for HPS component	$4.60 \pm 0.51$	40% good, 60% excellent
Valuable for future CME activities	$4.40 \pm 0.74$	33% agree, 53% strongly agree

**Conclusions:** Despite our relatively small sample size, it seems that HPS of pediatric emergencies has perceived benefits for even seasoned pediatric practitioners, highlighting the potential role of simulation in future professional education activities.

**Feasibility of Sharing Simulation-Based Evaluation Scenarios in Anesthesiology**

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**Introduction:** A recent international survey found that simulation is being used for postgraduate evaluation and accreditation of anesthesiologists by only 7-14% of simulation centers<sup>1</sup>. One of the suggested reasons for this apparent under-utilization was the lack of standardized, valid and reliable scenarios. An accompanying editorial to this article expressed the belief that international collaboration among centers is of paramount importance to overcoming this obstacle<sup>2</sup>. However, collaboration itself is made difficult by differences in language, education and anesthesia practice. The aim of the present study was to evaluate the feasibility of international collaboration by assessing simulation-based evaluation tools, developed in the USA, in Israel.

**Methods:** 31 junior anesthesia residents participated in training conducted at the Israeli Center for Medical Simulation (M.S.R). Four simulation scenarios - esophageal intubation, anaphylaxis, chronic obstructive pulmonary disease exacerbation and myocardial ischemia - previously validated in a multi-institutional study in the USA, were used<sup>3</sup>. Training sessions were videotaped and performance was assessed using 2 validated scoring systems ("long" and "short" forms) by two independent raters. Following training, participants rated the plausibility of the scenarios. The original scoring systems were revised by 15 Israeli anesthesiologists and the revised version used for a second reliability assessment.

**Results:** 25 out of 31 participants (80%) rated the scenarios as very realistic (grade 4 on a 1-4 scale) and only minor changes were performed in the scoring system by the Israeli experts. Subjects were scored from 37 to 95 ( $70 \pm 12$ ) (mean  $\pm$  2SD) out of 108 possible points with the original long form scoring system. Short-form scores ranged from 18 to 35 ( $28.2 \pm 4.5$ ) out of 40 possible points. Scores higher than 70% of the maximum score were achieved by 61% of participants in comparison to only 5% in the original study. Reliability of the original assessment tools was demonstrated by 0.66 internal consistencies for the long and 0.75 for the short form (Cronbach  $\alpha$  statistic). Values in the original study were 0.72-0.76 for the long and 0.71-0.75 for the short form. The reliability did not change by using the revised version of scoring. Interrater reliability measured by Pearson correlation was 0.91 for the long and 0.96 for the short form ( $P < 0.01$ ).

**Conclusion:** The feasibility of using simulation-based evaluation tools, developed in the United States, in Israel, is supported by the high scores for plausibility given to the scenarios, the high rate of agreement with the checklist items by Israeli experts and the similar reliability of the original assessment tool. The higher scores achieved by Israeli residents are related most probably to the fact that most Israeli residents enter residency training with more clinical experience than their American counterparts (immigrants from foreign countries).

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## An observation method to assess coordination processes in anesthesia

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### Background and Goal

In various domains high performing crews have been described to adapt several aspects of their coordination processes to the situational requirements. In anaesthesia, coordination processes in routine vs. non-routine situations have not yet been investigated. Based on task analysis we developed an observation method for coordination processes in anesthesia and tested its descriptive validity (sensitivity to situational changes) in a pilot study in a simulator setting.

### Materials & methods

We recorded the coordination processes of 24 videotaped MH scenarios (ACRM1 courses 1998-2003) using a predefined set of observation categories (Table 1). We compared the coordination behavior during routine and non-routine segments of the scenarios (paired-samples test).

### Results

Figure 1 illustrates changes in the work process and the related coordination behavior of during a simulated MH scenario. On a group level, several differences can be noted in the coordination processes during the routine and the non-routine segment of the scenarios. During the routine segment the observed crews spent significantly less time on coordination than during the non-routine segment ( $T_{(df=23)}=-22.524$ ,  $p<.001$ ). During the non-routine segment the time spent on task management activities increases significantly ( $T_{(df=23)}=-15.269$ ,  $p<.001$ ). However, information management remains the dominant coordination behavior with a significant increase in time spent on information management ( $T_{(df=23)}=-16.372$ ,  $p<.001$ ). There is a significant decrease of coordination via the work environment ( $T_{(df=23)}=2.905$ ,  $p<.01$ ) and of communication not related to coordination ( $T_{(df=23)}=5.236$ ,  $p<.001$ ).

### Conclusions

In this pilot study, we have shown that our methodological approach to analyze coordination processes in anaesthesia is sensitive to changes in the situational requirements. Based on these results we will conduct quantitative and qualitative analyses of how anesthesia crews adapt when confronted with non-routine situations in a simulator setting.

### Acknowledgements

This study was funded by the Swiss National Science Foundation (PBZH1-100994).

Table1: Observation system for coordination processes

Content	Number of categories	Who executes the coordination activity?					Anesthesia crew to...			Total
		HS	FR	S	RN	O	S	RN	O	
Information management	12	✓	✓	✓	✓	✓	✓	✓	✓	96
Task management	12	✓	✓	✓	✓	✓	✓	✓	✓	96
Coord. via work environment	3	✓	✓	-	-	-	-	-	-	6
Metacoordination	1	✓	✓	✓	-	-	-	-	-	3
Clinical work process	3	✓	✓	-	-	-	-	-	-	3
Other communication	3	-	-	-	-	-	-	-	-	3
Other	1	-	-	-	-	-	-	-	-	1
Total	34									208

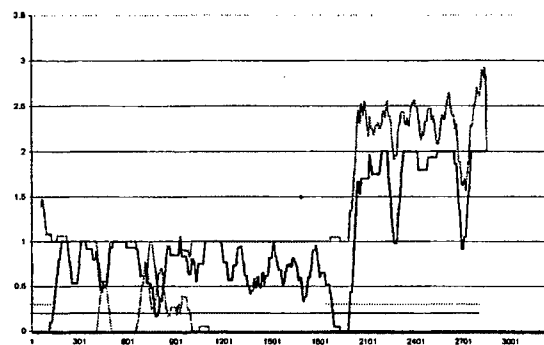


Figure1: Work and coordination process during a simulated MH scenario (case1).

## The Evaluation of Patient Simulator Performance as an Adjunct to the Oral Examination for Senior Anesthesia Residents

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**Introduction:** Full-scale realistic patient simulators possess attractive features for performance assessment and should be considered for summative evaluations. However, questions regarding the reliability, validity, and value-added of simulator-based examinations remain not well studied (1). This study compared a simulator-based examination with the traditional oral examination.

**Methods:** 20 final-year anesthesia residents at the University of Toronto were assessed in resuscitation and trauma scenarios using two assessment modalities: oral examination, followed by simulator-based examination using the SimMan™ Universal Patient Simulator (Leardal™). Two Royal College examiners scored all performances with a previously validated global rating scale developed by the Anesthesia Oral Examination Board of the Royal College of Physicians and Surgeons of Canada. Different examiners were used to rate the oral and the simulation performances.

**Results:** The internal consistency of the rating scale was excellent across scenarios, raters, and assessment modalities: Cronbach's  $\alpha$ : 0.93 to 0.98. The inter-rater reliability was good to excellent across scenarios and modalities: Oral examination:  $r = 0.79^*$  (Resuscitation) and  $0.86^*$  (Trauma); Simulation examination:  $r = 0.88^*$  (Resuscitation) and  $0.76^*$  (Trauma) (\*  $p < 0.01$ ). Average total scores for both raters obtained in the oral exam were then correlated with the corresponding scores obtained during simulation. The Pearson correlation coefficient reflects the concurrent-related validity of the simulation-based examination compared to the oral examination for each scenario: Resuscitation:  $r = 0.52^{**}$ ; Trauma:  $r = 0.53^{**}$  (\*\* $p < 0.05$ ).

**Conclusions:** Clinical performance can be evaluated using simulators as reliably as the oral examination. The moderate level of concurrent validity, in conjunction with high reliability suggests that simulator-based assessment may be measuring different but important dimensions of clinical competence compared with the oral examination, and therefore may be considered a useful adjunct.

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**TOPIC: Use of simulators for training non-physician healthcare professionals****An Introduction to Clinical Medicine for Biomedical Engineering Students through Simulation**

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 Pete Santiago, Ph.D., Virginia Tech - Wake Forest University School of Biomedical Engineering and Sciences

**Objective:** A two-day simulation curriculum was developed as an introduction to clinical physiology and surgical anesthesiology, for seven doctoral students from the Virginia Tech - Wake Forest University School of Biomedical Engineering and Sciences (SBES) completing their first postgraduate year. Arranging "hands-on" clinical experience with patients for these students would have been very difficult or impossible, given patient confidentiality, liability, and credentialing issues.

**Description:** In June 2004 SBES implemented its first month-long clinical rotation for their first year Ph.D. students. Included in the month was a two-day session in the Patient Simulation Laboratory of WFUBMC, to introduce students to "hands-on" clinical anesthesiology/critical care medicine, as an adjunct to their physiology and anatomy courses and immediately following two days in the Gross Anatomy Laboratory, and to introduce them to a number of products designed by their professional colleagues. There were seven sections (not including a brief introduction to the PSL), described briefly below. The students received a course syllabus several weeks prior to the start date, which included a schedule outline, specific objectives for each section, and reading materials to supplement the coursework. They also received two brief videos covering an Orientation to the PSL, and Induction Choreography (of a simulated general anesthetic on the METI simulator). Although participation in the simulation course was mandatory, no formal evaluation was given to the students at its completion. All seven students anonymously completed a post-course survey (answers in a Likert scale format from 1 to 5), which queried them about the overall utility of the course (10 questions), subjects included (4 questions), syllabus outline and objectives (4 questions), reading materials (3 questions), and the simulations (9 questions). The survey also included a section soliciting general comments and suggestions for future courses.

Equipment used for the simulation course included an METI HPS mannequin and software, Laerdal SimMan mannequin and software, Datex-Ohmeda Aestiva 5 anesthesia machine and monitor, airway and disposable devices from multiple manufacturers, and the Zoll M Series pacer/defibrillator.

Each of the course's seven sections was roughly two hours in length, covering the following subjects: Basic Anesthesia Setup, Basic Airway Management /Induction Choreography, Respiratory Physiology, Cardiovascular Physiology, Basic Physiologic Monitoring, Modern Anesthesia Machines, and "Tinker Time." The sections were designed to provide a "hands-on" introduction to airway equipment and management, simulated anatomy, basic anesthetic drugs and induction, monitoring devices, anesthesia machines, and "clinical" demonstrations of physiology and pathophysiology, in simulation. They included brief lectures on each of the subjects prior to the simulation portion. The "Tinker Time" section gave students unstructured time to explore any equipment in the PSL they wished, as well as extra time with a clinician to investigate unanswered questions related to clinical material and equipment.

**Survey Results:** As a summary of the survey, the participants generally rated the course as having a high overall utility with a good choice of subjects, to supplement their clinical and classroom experience. The syllabus was typically felt to have too much reading material. The simulations were well-received. 86% reported that the course stimulated the interest in the clinical connections of BME. 86% also felt the covered subjects were useful to their education as a BME. 100% felt that the simulations achieved the stated objectives. 100% reported a better understanding of cardiovascular and respiratory physiology, introductory airway management, and basic physiologic monitoring. General comments revealed that several of the learners found the lecture portions too long, but the found the simulations and "hands-on" opportunity very useful. Also, there were multiple comments that the students "learned a lot" and found the course enjoyable. Some selected comments: "Great course!"; "This was very useful to me."; "I was definitely better equipped to understand my OR rotation..."; "Overall, the experience was very satisfactory."

**Discussion:** We developed a two-day simulation-based course to enhance first year doctoral biomedical engineering students' understanding of applied physiology, patient monitoring, and anesthesia equipment, as well as to introduce them to clinical patient care. The post-course survey results suggest that the course objectives were achieved in the PSL. Next year's course will include a more simplified syllabus and reading material, as well as shortened lecture time, in accordance with the survey results.

**Topic: Use of simulators for assessment and training of technical skills**

**A Novel (?) Five Day Human Patient Simulation Curriculum for Anesthesiology Residents**

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**Objectives:** The Wake Forest University Department of Anesthesiology has developed a week-long curriculum in simulation for CA-1 through CA-3 residents, with the objectives of documentation of progressive learning of behaviors and skills, preparation for successful management of critical incidents, introduction to and practice of the principles of Crisis Resource Management, and mastery of technical anesthesia skills. We are unaware of the description of any other such curriculum in the literature.

**Description:** Three to four residents per group, from training levels CA-1 to CA-3, have participated in two (at the time of this writing) five-day simulation courses, in the Patient Simulation Laboratory of WFU Baptist Medical Center, as a part of their month-long "Off-Site" Anesthesia rotation. They are free from clinical and call responsibilities for that week (Monday through Friday). Anesthesiology faculty facilitate and evaluate each day's learning activities. The residents receive a syllabus with required preparatory reading materials and a course outline with expectations and objectives at least one week in advance of the start day. All residents are familiar with the PSL from previous experiences.

The Day One morning consists of orientation and explanation of the syllabus and readings, an introduction to Crisis Resource Management, and a workshop on problem solving skills. The residents then participate, as a group, in a full-scale simulation of a critical incident in the operating room which includes actors (surgical technician students) in the roles of surgeons, technicians, and nurses. The residents are evaluated during this scenario for technical and behavioral performance, and a video-taped, faculty-facilitated debriefing, including the actor participants, follows. Day One's afternoon covers six "rapid-fire" simulated critical incidents (also videotaped), during which the residents' performance is evaluated with a technical skills checklist. Two or three residents initially manage each incident, and if there are extras, they are available to be called for help. Limited debriefing occurs during and after this section. The technical and behavioral checklists are distributed to the learners at the end of the day.

On Day Two the curriculum concentrates on mechanical technical failures and skills training, with an emphasis on airway and ventilatory management. Day Three covers cardiac arrest and perioperative resuscitation skills training, with an emphasis on ACLS review. Day Four covers more specific anesthesia critical incidents and scenarios, such as intraoperative management of AAA, anaphylaxis under general anesthesia, malignant hyperthermia, subdural hematoma in a complicated patient, and others. Simulations on Days Two through Four are conducted at a pace allowing consideration of multiple management issues and perfection of skills and behaviors. Crisis Resource Management principles are emphasized throughout. Minimal time is dedicated to lecturing, in order to maximize hands-on time in simulation, and much cognitive information is supplied prior to the start in the syllabus materials (as well as throughout residency!) Relevant supplemental reading material is distributed on these days.

Day Five concludes with several last teaching scenarios as in Day Four, followed by a final full-scale critical incident scenario, including actors. Performance is evaluated using technical and behavioral checklists, and a videotaped debriefing that includes actor input. Another six "rapid" critical incidents are covered in the afternoon, including the skills learned during the week, with technical performance markers measured. Group learning, evaluations, and progress through the week are discussed. Individual feedback occurs privately.

A grading scale (available to the residents in the PSL syllabus) for performance for the week has been developed, with a "curve" to incorporate the progression of performance from CA-1 through CA-3 level. CA-1s are expected to receive a lower grade than more senior residents. The scale incorporates technical and leadership skill expectations, familiarity with current literature, as well as problem-solving abilities, attendance, and judgment as compared to that of a consultant anesthesiologist.

**Discussion:** This simulation curriculum incorporates learning and practice of technical and behavioral skills in anesthesia, with preliminary tools for assessment of performance, and progression of performance from CA-1 to CA-3 level residents. Further refinements of the scenarios and techniques to include approval by a majority of departmental faculty will be enacted in the future. Additionally, validation of our evaluative tools should be performed. The curriculum addresses the ACGME-defined core competencies of Professionalism, Interpersonal and Communication Skills, Medical Knowledge, Patient Care, and Practice-Based Learning and Improvement.

**\*Equipment:** Mannequin-based simulations using both METI HPS and Laerdal SimMan are included in this curriculum.



## The utilization of the anesthesia simulator room at Hyogo College of Medicine during the three years, from April 2001 to March 2004

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Human Patient Simulator (HPS) was installed in the anesthesia simulator room of Hyogo College of Medicine (HCM) in March 2001. In this presentation, we summarized the utilization of the simulation room during the three years, from April 2001 to March 2004.

**Facility and Equipment:** The anesthesia simulator room is located in the semi-clean zone of a central operating room of HCM. Its area is 24 $\square^2$ , and maximum of 10 participants can be trained. There are one HPS (version 5.5 Type C, METI, FL), an anesthesia machine (Ohmeda, Excell), an anesthesia monitor (Phillips), a ventilator, and equipment for presentations (a PC and a LCD projector). The central pipeline, which is required for HPS operation and anesthesia training including CO<sub>2</sub>, were installed. Internet connection via LAN is available. AirMan (Laerdal) was purchased in March 2003.

**Operation and Maintenance:** The staff anesthesiologists of the anesthesia department operated the HPS in the simulation room. There was no support for maintenance of HPS until March 2004. Currently HCM signed the annual contract for maintenance of HPS with the local distributor.

**Utilization of the simulator room:** We trained 1038 participants in the simulation room from April 2001 to March 2003: 737 medical students, 123 anesthesiologists, 73 anesthesia residents, and 105 nurses. The number of participants per year decreased from 441 to 279, but the total annual utilization time increased from 12505 to 22090 minutes. The utilization rate of the simulation room improved from 10.0% in 2001 to 17.8% in 2003. The number of participants multiplied by utilization time also increased from 74860 to 92075 minutes\*peoples, and average training period increased from 170 minutes to 330 minutes. This year, the training of the residents in new residency program, which started from April 2004 in Japan, began as one of the main targets of the training. We expect that the utilization time and utilization rate will improve in 2004.

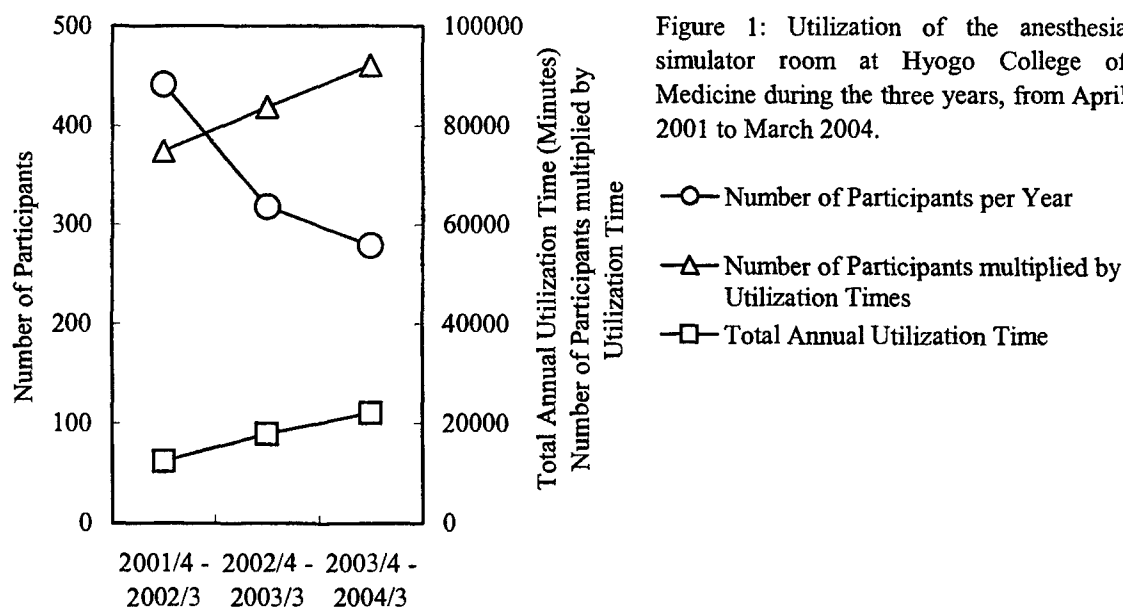


Figure 1: Utilization of the anesthesia simulator room at Hyogo College of Medicine during the three years, from April 2001 to March 2004.

## Is ACLS knowledge valuable for anaphylactic shock treatment? Simulation study in medical students.

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**Introduction:** Advanced cardiovascular life support (ACLS) training has been getting worldwide popular even in medical students. ACLS training can provide the basic skill of clinical management for patients' crisis including airway support, circulatory support. We thought, therefore, the students had experienced ACLS workshop had more knowledge to treat anaphylactic shock. This simulation study was conducted to assess whether ACLS knowledge affected the learning of anaphylactic shock treatment.

**Method:** Fifty-one of 6th year medical students in our university participated in this study. All students had taken the class of anaphylactic shock treatment in their 5th year curriculum. Fourteen of all 51 students had experienced ACLS workshop before this study. According to a clinical practical program, these students were divided into 13 groups, each of three to five students. Consequently, 10 of all 13 groups included the students with ACLS knowledge as members of group. Before starting this simulation study, we formed an anaphylactic shock scenario with high fidelity human simulation training device (METI™) and created the checklist to assess the students' performance during the simulation. This checklist was consisted of 14 items that were related for shock management: appropriate vital and physical check; process of diagnosis; time to start treatment; essential treatments; etc. The essential treatments were as follows: ventilation with 100% oxygen; increase volume infusion; trendelenburg position; intravenous adrenaline and so on. The each item was rated from two to fifteen points depending on the necessity for the shock managements and perfect score was one hundred points. The scenario simulation workshop was performed by the group after familiarizing the students with simulator environment. The management skill of anaphylactic shock simulation was assessed using the checklist. After the workshop was finished, the students answered some questionnaires about this simulation.

**Results:** Mean checklist score of 10 groups, each of those including the student with ACLS knowledge, was significantly higher than that of the residual three groups ( $55.1 \pm 15.9$  vs.  $30.0 \pm 11.5$ ). The students with ACLS knowledge were likely to become a leader in each group and ordered the other members to treat the patients at the early stage. All participants were satisfied with our simulation program.

**Summary:** Our results have demonstrated that the group including the students with ACLS knowledge could well manage anaphylactic shock compared with the group not including student with ACLS knowledge. Therefore, this study indicated that ACLS knowledge could be valuable to learn and develop the essential skill of anaphylactic shock treatment and it might be useful to treat the other kind of patients' crisis.

## INTRODUCTION

The Department of Anesthesia introduced a "procedural skills development day" in the Canadian Simulation Centre as part of the 4th year undergraduate rotation. The purpose of the day was to address the need for increased exposure to technical skills training. (1,2) Students are given the opportunity to practice a variety of technical skills using both part-task simulated models and high-fidelity simulation.

## METHODS

The educational sessions are held every 2 weeks. Approximately 10-14 students participate per session for a total of 15 sessions throughout the academic year. Upon arrival, students complete an entry questionnaire regarding their previous exposure to a variety of procedural skills. Students are given an orientation to the Simulation Centre and to each of the 5 stations which include; 1, Patient Monitoring (Datex Light portable monitor); 2, Intravenous insertion (2 Laerdal IV training arms); 3, Bag-mask ventilation and endotracheal intubation (Laerdal Airway Management Trainer); 4, Laryngeal mask insertion (METI AirSim); and 5, High-fidelity simulation scenario focusing on induction and maintenance of general anesthesia and management of a clinical scenario (Eagle MedSim high-fidelity patient simulator). The students are divided into groups of 2-3 and given 45 minutes at each station. Learning objectives and tasks that the students are expected to complete are provided at each station. The learning objectives were developed from the undergraduate curriculum at the University of Toronto. Each station also contains relevant reading material to guide the students through the objectives and tasks. Three facilitators and a simulator operator are present to help guide the students through each of the 5 stations. Upon completion of all stations, students participate in a focus group to express their opinions of the educational project and complete an exit questionnaire and facilitator evaluation. Students were asked to rate each of the stations on a scale of 1 to 5, with 1= no educational value, and 5= very valuable educational experience. Student participation is voluntary.

## RESULTS

Interim data from 32 students was analyzed. The results are listed in Table 1.

Station	Mean $\pm$ SD	Station	Mean $\pm$ SD
Patient monitoring	3.8 $\pm$ 0.80	LMA insertion	4.4 $\pm$ 0.78
Intravenous catheterization	4.0 $\pm$ 0.91	High-fidelity simulator	4.9 $\pm$ 0.34
ETT intubation	4.6 $\pm$ 0.62	Was this a useful learning experience?	4.8 $\pm$ 0.52

Table 1

## DISCUSSION

There is reported decreased procedural skills exposure in undergraduate medicine. (1,2) A procedural skills development day using simulated models is being offered to undergraduates to address this concern. Participants rated this type of education as being valuable and a very useful learning experience. Simulation enables students to practice technical skills and to improve both confidence and competency in performing these skills.

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# Using Patient Simulators to Reinforce Emergency Response Training for Non-clinical Personnel

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## Introduction:

Since January 2003, the Louisville Metro Department of Health, in cooperation with several local agencies, including the University of Louisville - School of Medicine, has been offering a monthly training course on Community Based Emergency Response (CBER) for all U.S. public health employees. In the first fifteen months, the program boasts 398 participants from 18 states, as well as Puerto Rico, Guam, and Ghana. As part of this training program, we present a botulism case, using patient simulators, to reinforce some of the concepts taught during the didactic portion. This effort is supported by the Centers for Disease Control.

## Hypothesis:

Patient simulators can be used effectively within a larger, multi-purpose training course to reinforce concepts taught to non-clinical personnel.

## Methods:

The same simulation case, botulism, is used for each group. The session typically lasts 45 minutes. The participants are presented with a case of a patient brought into the ED in respiratory distress. They are provided the opportunity to ask questions of the "patient", which are answered by the instructor. After a few minutes of history taking, the "patient" loses consciousness, and the group is required to treat the patient. The instructor walks them through the primary assessment and ABC's, with the participants ventilating the patient using a bag-valve-mask. Then, the diagnosis of botulism would be discussed, as well as the prognosis. The group determines that intubation and mechanical ventilation are required, and participants perform the procedures. Follow up treatment, resource requirements, and contingency planning are then discussed.

Participant perceptions were surveyed at the completion of the CBER program, using a 5-point Likert scale, where 5 is the most favorable score.

## Results:

The simulation sessions consistently rated greater than 4 (out of 5) in the post course assessments.

## Conclusion:

These sessions were a huge success in the CBER course. The botulism scenario proved to be an effective method of reinforcing the concepts being taught in the CBER course. It worked well for large groups of non-clinical personnel, since the clinical concepts were easily demonstrated and understood.

**TITLE** Creation, Implementation and Evaluation of a Nationwide Simulator Based CME Program for Family Practice Anesthetists

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**INTRODUCTION:** Family practice anaesthetists (FPAs) are essential to health care delivery in Canada, but have an average practice lifespan of approximately 5 years<sup>1</sup>, in part due to an isolated environment and lack of specific CME programs. A national collaborative effort has attempted to address this deficiency.

**METHODS:** **Creation:** in November 2001, simulation based education was discussed at a nationwide meeting on the current and future role of FPAs in Canada. Representatives from (at the time) all 8 high fidelity patient simulation centres were present and discussed learning objectives, administration and financing of a national program. Subsequently, a needs assessment was performed using focus groups and trial courses for 16 participants. Specific scenarios were developed and tested. Startup funding came from, Health Canada, Alberta Rural Physician Action Plan, and University of Alberta.

**Implementation:** Brochures were printed and widely distributed by direct mail and at regional meetings. Invitation and information letters were sent to administration at every rural hospital in Canada. Word of mouth was encouraged. Two sites were initially chosen (Edmonton/Toronto) due to geographical and logistic considerations. Teleconferences and e-mail were used to continue and complete the implementation arrangements.

**Evaluation:** Three methods of evaluation were used. Participants complete evaluations at the end of the course. A second evaluation is completed 3 months later and CME credits are withheld until return of this form. An external review and evaluation of the program was performed by a professional evaluation consultant after 2 years. The cost of this evaluation was included in the initial program budget.

**RESULTS:** The first courses were held in November 2002. Due to demand a third site (Ottawa) was added in April 2004. there have been 5 courses in Edmonton, 6 in Toronto, and 1 in Ottawa for a total of 54 participants (excluding the focus groups). Evaluations have been consistently very good to excellent. Several changes were made based on the feedback.

**DISCUSSION:** Through a national collaborative, a simulator based CME program for FPAs was developed, implemented and evaluated. Federal, provincial, and academic start up funds were essential for the success of the program initially. The course is now financially self sufficient based on registration fees of \$600 CDN for the one day course. Course evaluation, using repeated and varied measures, ensures meeting the educational objectives of the participants, and provides a mechanism for continuous quality improvement of course content.

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## Comparison of Student Perceptions of Web-based Virtual Reality and HPS Simulation Training in Trauma Management

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### Introduction

Team Training in trauma management is an important component of emergency medicine training programs. Effective trauma management requires both clinical proficiency and team leadership ability, skills best developed through experiential learning. However, practice on live patients is not always practical, and high-fidelity teaching tools such as the Human Patient Simulator (HPS) are expensive and do not allow distance learning. To address the need for other training options, our team of academic surgeons, software developers, and medical educators developed and tested a Virtual Emergency Department (V-ED) for team training in trauma management. We report the results of a study of student perceptions of the V-ED versus perceptions of the HPS.

### Methods

The V-ED is an innovative, web-based, distributed learning technology for team training. It allows trainees from geographically dispersed locations to manage a virtual patient together, using personal computers to log into the virtual world, take the role of a physician or nurse represented by an avatar, and select actions from a menu to assess and manage the patient. The patient's physiological parameters vary according to the actions taken by the team.

Twenty-two senior medical students and 8 first year EM interns were randomly assigned to the V-ED or the HPS group. Prior to the simulation, trainees studied basic trauma management and team leadership skills according to the EMCRM guidelines<sup>1</sup> using online self-study materials. After orientation, pairs of trainees were teamed with two standardized team members—an ED nurse and ED physician. Each team managed 6 cases: a pre-assessment case, four training cases, and a post-assessment case. Team leadership alternated with each case between the pair of trainees. An ED physician led debriefing sessions after each training case. The same cases were used in both the V-ED and HPS groups. After the entire session, each trainee completed a questionnaire assessing perceptions of the training method.

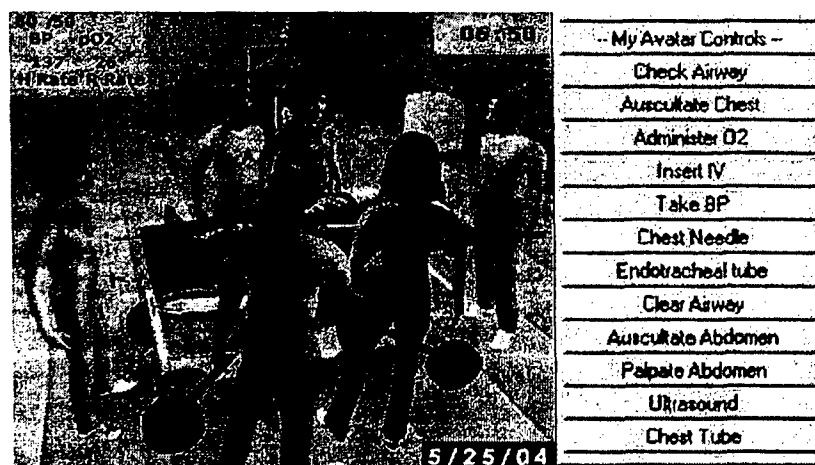
### Results

Trainees from both groups gave their simulator high ratings on a scale of 1-5 (1=lowest; 5=highest) for the sense of immersion, for improving their confidence levels, for usefulness in learning to assess and manage trauma patients, and for learning to work in a trauma team. When asked if this study changed their feelings/perceptions about working as a member or leader of an ED trauma management team, 12 out of 16 in the V-ED group and 12 out of 14 in the HPS group reported positive changes.

### Conclusions

These data show that trainees found both the V-ED and HPS highly effective methods for team training in trauma management, suggesting that the V-ED may provide a cost-effective complement or alternative to the HPS. In addition, it offers training for geographically dispersed team members.

<sup>1</sup> Reznick M, Smith-Coggins R, Howard S, Kiran K, Harter P, Sowb Y, Gaba D, Krummel T. (2003). Emergency medicine crisis resource management (EMCRM): Pilot study of a simulation-based crisis management course for emergency medicine. *Academic Emergency Medicine*, 10: 386-389.



## Simulation as an Integral Component of an Emergency Medicine Residency at Harvard

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1. STRATUS Center for Medical Simulation, Department of Emergency Medicine, Brigham and Women's Hospital, Boston, MA
2. Brigham and Women's Hospital and Massachusetts General Hospital Harvard Affiliated Emergency Medicine Residency Boston, MA.

We describe an innovative model of emergency medicine (EM) residency education integrating knowledge acquired through traditional reading/problem-based seminars with real-time simulations that facilitate active learning through case management performed under direct faculty supervision without exposing patients to risk. The Brigham and Women's Hospital and Massachusetts General Hospital Harvard Affiliated Emergency Medicine Residency (HAEMR) is a four-year residency in emergency medicine. STRATUS, a medical simulation center based in the department of Emergency Medicine, incorporates micro-simulators (computer-based patient simulations), partial task simulators, and high-fidelity human patient simulators.

Each module of the EM core curriculum was reviewed, specific goals and objectives were defined, and the learning process best suited to achieving each objective was specified. Topics were presented employing one of four approaches: case-based seminars with pre-assigned reading, facilitated problem-based learning employing micro-simulations, partial-task training, and human patient simulations. Residents were segregated into two groups by class in order to ensure content appropriate to level of training and to enhance leadership opportunities during simulations. While one group attended the problem-based seminar, the other was rotating through stations in the simulation center. Roles were reversed after 90 minutes. These sessions occur bi-weekly, alternating on the other weeks with traditional classroom teaching, as was used before the introduction of the new model. Post simulation debriefing was stressed for both identification of additional learning opportunities and to provide immediate, faculty-level feedback on simulations and procedures. All residents were asked to complete a survey after each simulation-based curriculum day.

Thus far, seven modules have been presented employing this methodology: cardiac arrhythmias, acute coronary syndromes, congestive heart failure, reactive airway diseases, the difficult airway, trauma, and endocrine emergencies. Residents (N=119) were asked to rate each of the following characteristics of the simulation component on a scale of 1-5 (5 representing the highest possible score). Compilation of resident surveys are reported below:

Effective Method	Challenging Scenarios	Realistic Scenarios	Debriefing	Faculty	Course Challenging	Utility
4.71 +/- 0.58	4.6 +/- 0.52	4.5 +/- 0.65	4.7 +/- 0.52	4.76 +/- 0.45	4.56 +/- 0.54	4.85 +/- 0.42

Many emergency medicine residencies are beginning to employ medical simulation in their curricula. Our model is unique in that it involves full-scale curriculum redesign to capitalize on the full potential of medical simulation, rather than just adding simulation into an existing curriculum. Future studies will address comparative learning in the new versus the old model, and development of metrics to evaluate both knowledge retention and clinical competency over time.

## Exploration of Partial Task and Variable Priority Training for Anesthesia Residents to Improve Management of Adverse Respiratory Events: Preliminary Results

Noah Syroid, Diane Tyler, Lazarre Ogden, Julia White, Frank Drews, David Strayer,  
Wesley Mortensen, Micheal Malan, Eddie Lu, Joshua Larsen, Jason Poulson,  
Santosh Balakrishnan, Srinath Lingutla, Dwayne Westenskow, Ken Johnson

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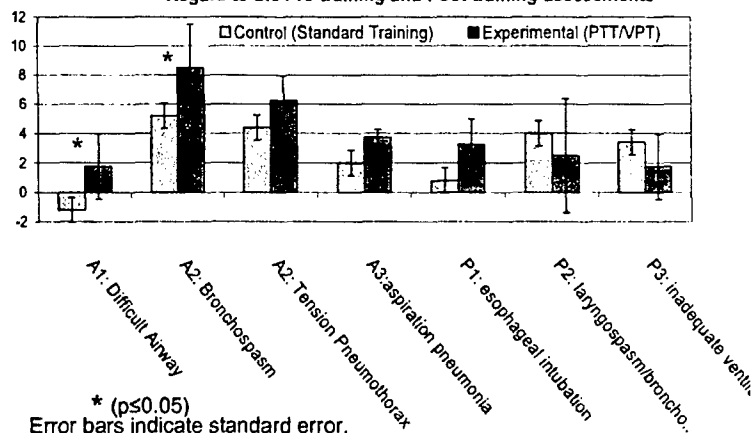
**Introduction:** Part task training (PTT) focuses on dividing complex tasks into small components followed by intensive concentrated training on each individual component. The goal of part task training is to reduce the magnitude of processing demands when performing multiple complex tasks simultaneously by developing levels of automaticity. Variable priority training (VPT) focuses on optimal distribution of attention when performing multiple tasks simultaneously. The goal of variable priority training is to allow resource allocation to be priority driven. The aim of this study was to explore how PTT and VPT implemented over a twelve month period would improve first year anesthesiology residents' management of simulated adverse respiratory events when compared to conventional training methods. We hypothesized that participants with PTT and VPT would complete more critical evaluation and treatment tasks for simulated adverse respiratory events than those with standard training.

**Methods:** After IRB approval, ten first year University of Utah anesthesia residents were enrolled and randomly assigned to two groups. Residents in the control group received conventional didactic and simulation training, which included five 90 minute simulation sessions and forty 45 minute "grand rounds" didactic sessions throughout the year in addition to clinical training in the operating room. Residents in the experimental group received five 90 minute simulation sessions that emphasized VPT, fifteen 45 minute didactic PTT sessions and twenty-five 45 minute traditional "grand rounds" didactic part-task training sessions in addition to clinical training in the OR. Students were assessed for competency on the management of adverse respiratory events prior to and after the twelve month training period. Six simulations, three adult (unanticipated difficult airway, bronchospasm and tension pneumothorax, aspiration pneumonia) and three pediatric (esophageal intubation, laryngospasm and bronchospasm, inadequate ventilation due to air circuit leak) were used to test the participants. During each simulation, investigators recorded the monitoring and treatment tasks completed by the residents.

**Results:** A main effect of training (VPT/PTT) was not observed with regard to managing simulated adverse respiratory events. One-tailed t-tests indicate that the adult difficult airway ( $t=1.9$ ,  $df=7$ ,  $p<0.05$ ) and bronchospasm simulations ( $t=2.0$ ,  $df=7$ ,  $p=0.05$ ) were statistically significant and trending towards significance respectively with regard to the change in the number of tasks completed from pre-training to post-training assessment (Fig. 1).

**Discussion:** The preliminary results indicate that residents with PTT and VPT may be able to complete a greater number of relevant monitoring and treatment tasks when managing simulated adverse respiratory events. A second year of study with additional first-year residents is required to better elucidate the effects of PTT and VPT.

Figure 1: Average Change for the Number of Tasks Completed with Regard to the Pre-training and Post-training assessments





**Introduction of Part Task and Variable Priority Training in First Year Anesthesia Resident Education: A combined didactic and simulation based approach to improve management of adverse respiratory events.**

Ken Johnson, Frank Drews, David Strayer, Diane Tyler, Lazarre Ogden, Julia White, Michael Malan, Wesley Mortensen, Eddie Lu, Joshua Larsen, Jason Poulson, Santosh Balakrishnan, Srinath Lingulta, Noah Syroid, Dwayne Westenskow

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Enhanced training techniques have been successfully employed to improve performance in domains that require efficient multi-tasking skills. Some of these techniques include part task training (PTT) and variable priority training (VPT). PTT focuses on dividing complex tasks into small components followed by intensive concentrated training on each individual component. The goal of PTT is to reduce the magnitude of processing demands when performing multiple complex tasks simultaneously by developing levels of automaticity. VPT focuses on optimal distribution of attention when performing multiple tasks simultaneously. The goal of VPT is to allow resource allocation to be priority driven.

Given that adverse respiratory events often occur during a time period where anesthesiologists perform multiple tasks at once, clinicians can quickly get overwhelmed when attempting to formulate an accurate diagnosis and appropriate treatment plan in a timely fashion. Skills acquired through PTT and VPT may improve vigilance in detecting and responding to these types of life threatening events. Hence we employed PTT and VPT techniques as part of an enhanced didactic and simulation based training for first year anesthesia residents (CA1's) over a 12 month period.

To implement PTT, we identified four areas of clinical competence in managing an adverse respiratory event that would benefit from an increased ease of recall during a critical event: (1) the ASA Difficult Airway Algorithm, (2) a differential diagnosis for hypoxia, (3) treatment options for each item in the differential diagnosis, and (4) a readily available knowledge of normal ranges of cardiopulmonary variables and key relationships between selected variables. We built and used computerized flash cards to document training performance in each of these four areas. The computerized flash cards documented the time required to get through a set of questions and the number of correct responses. The intent of this segment of training was to enhance learning in these four areas to the point where useful material could be easily recalled during a critical respiratory event.

To implement VPT, participants were asked to review four major areas of patient data during a simulated adverse respiratory event: pertinent findings from the patient history, a brief targeted physical exam (i.e. the ABC's), physiologic data, and mechanical ventilation data (if available) for a confined period of time. Following each observation time, participants were asked to recall data from each of the four major areas. As their ability to recall information improved, the observation time was incrementally reduced until each participant could accurately recall all pertinent patient data after only a 60 second exposure. Subsequently, in addition to recalling pertinent patient data, participants were asked to utilize their PTT to generate a differential diagnosis, perform additional diagnostic and therapeutic maneuvers, and converge on a definitive diagnosis and treatment plan in a time sensitive fashion.

PTT and VPT were successfully implemented in the didactic and simulator based training for first year anesthesia residents. Following the 12 month enhanced training session, first year anesthesia residents appeared to have improved skills in managing simulated adverse respiratory events; however, current metrics of resident performance are likely to be insensitive for detecting improvement when managing adverse respiratory events clinically. Future work is warranted to determine the long term benefit of PTT and VPT to improve (i) clinical skills in managing adverse respiratory events and (ii) patient outcome following a life threatening respiratory event.

Simulation of Pediatric Trauma Stabilization in North Carolina Emergency  
Departments: Identification of Targets for Performance Improvement

Elizabeth A. Hunt, MD, MPH, Susan M. Hohenhaus, RN, BS, Xuemei Luo, PhD,  
Karen S. Frush, MD

## ABSTRACT

*Objective:* Trauma is the leading cause of death in children. Most children present to community hospital Emergency Departments (ED) for initial stabilization. Thus, *all* EDs must be prepared to care for injured children. The objectives of this study were to: 1) characterize the quality of trauma stabilization efforts in EDs and 2) identify targets for educational interventions.

*Methods:* Prospective observational study of simulated trauma stabilizations, i.e. "mock codes", at 35 North Carolina EDs. An evaluation tool was created to score each mock code on 44 stabilization tasks. Primary outcomes were: 1) inter-rater reliability of tool, 2) overall performance by each ED and 3) performance per stabilization task.

*Results:* The inter-rater reliability of the evaluation tool was excellent: weighted Kappa 0.77 [95% CI: 0.74 – 0.79]. Median number of stabilization tasks failed by EDs was 25/44 tasks (57%), [Range: 8/44 (18%) - 32/44 (73%)]. Although problems were ubiquitous, tasks uniquely important and/or complicated in pediatric stabilizations were *failed* by many EDs, including: 1) estimation of child's weight [17/35 EDs, 49%], 2) preparation for intraosseous needle placement [24/35, 69%], 3) order for intravenous fluid bolus [31/35, 89%], 4) application of warming measures [34/35, 97%], and 5) order of dextrose for hypoglycemia [34/35, 97%].

*Conclusion:* This study used simulation to identify deficiencies in stabilization of children presenting to EDs, revealing that mistakes are ubiquitous. ED personnel were universally receptive to feedback. Future research should investigate whether interventions aimed at improving identified deficiencies can improve performance, and ultimately the outcomes of children who present to EDs.

# Use of a simulation-based training program at NF/SG VA Health System to train residents and nurse practitioners in Lower Gastrointestinal Tract Endoscopy

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<sup>2</sup>University of Florida, College of Education, Gainesville, Florida

Funded by North Florida Foundation for Research and Education (NFFRE)

**Background:** Colorectal cancer is the 4<sup>th</sup> most common cancer and the second cause of cancer deaths in the United States. The demand for colon cancer screenings and limited availability of providers has created a backlog of patients waiting for this procedure. Commercial VR simulators are currently available to teach a variety of procedural tasks including endoscopy. Traditional medical procedure training comprises the "see one, do one" method of teaching. Several recent studies validate the ability of simulators to accelerate the learning curve for novice endoscopists. Nurses in the UK have been performing endoscopic procedures in the since the 1970s<sup>1</sup>. A recent study out of the UK reports success in the training of nurses in endoscopic procedures using a simulator<sup>2</sup>, however there is little research data available on the translation of performance on the simulator to actual patient encounter.

**Hypothesis:** Nurse practitioners performance can be equivalent to surgical residents using comparison of data collected on Immersion lower endoscopy simulator looking at percent of mucosa visualized, patient discomfort and visualization of abnormal anatomy.

**Methods:** This paper discusses the simulator data on the random first participants introduced to the Immersion lower GI simulator curriculum. This is part of a larger study that will track learner's performance when they perform procedure on actual patients. Initial study participants comprised three types of learners: a senior resident trained in traditional see one do one mode, a third year surgical resident with limited endoscopy training and a nurse practitioner beginning endoscopic training using a simulator. After informed consent and completing a survey on baseline experience participants had the opportunity to complete the pre set modules on the simulator which included flexible sigmoidoscopy and colonoscopy.

## Results:

	initial lower GI case			last lower GI case		
	%Mucosa visualized	Discomfort %/time	Abnormality visualized Y/N	%Mucosa visualized	Discomfort %/time	Abnormality visualized Y/N
Senior Surgical Resident	95.35	.9/9secs	Y	99.79	2.14/15secs	Y
3 <sup>rd</sup> year resident	96.56	5.36/57secs	Y	99.62	2.35/15secs	Y
Nurse Practitioner	15.15	0/0secs	Y	62.75	3.06/73secs	Y

**Conclusions:** Though limited conclusions can be gathered from this limited initial sample, trend show that both groups improved over time. The senior resident's level of expertise was demonstrated. Nurse practitioner started out with no prior experience and focused on performing mostly flexible sigmoidoscopies. Further study needed to answer if residents' and Nurse practitioners' performance on the simulator will reflect performance on real patient encounters.

<sup>1</sup> Spencer, R.J., Utilisation of nurse endoscopists for sigmoidoscopic examinations. Dis. Colon Rectum 1977;20:94-96

<sup>2</sup> Kneebone, R.L., Nestel, D., Moorthy, K., Taylor, P., Bann, S., Munz, Y., & Darzi, A. *Learning the skills of flexible sigmoidoscopy – the wider perspective* Med Educ 2003;37:50-58

## COMPARISON OF SIMULATION-BASED, WRITTEN, AND SKILLS ASSESSEMENTS IN PREDICTING FIELD PERFORMANCE BY PARAMEDICS.

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<sup>1</sup>Ontario Air Ambulance Base Hospital Program; <sup>2</sup>University of Toronto, Toronto, Ontario, Canada.

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### Introduction:

An important component of any educational organization is the valid and reliable evaluation of its students. In recent years, there has been significant growth in the development of technology for the purposes of training and assessing health professionals. In particular, there is an increased use of high fidelity computerized mannequin simulators to train and assess health professionals in acute situations. While these computerized simulations offer significant promise to the field of paramedic training, little research has been conducted to determine whether assessments based on performance in simulated environments are valid or reliable. In a previous study, we demonstrated that performance on simulation-based exams correlated moderately with performance on written exams and skills-based exams<sup>1</sup>. In this current study, we explored whether performance on simulation-based exams could predict the field performance of flight paramedics as well as or better than performance on written exams or traditional skills stations.

### Methods:

We retrospectively obtained exam performance and patient chart audit information from 78 advanced and critical care flight paramedics undergoing annual re-certification in the 2003-2004 academic year. As part of the re-certification exam, the paramedics completed a written exam (75 items), a traditional mannequin-based skills exam (3 stations) and a high-fidelity simulation exam (2 stations).

Patient chart audits were conducted by blinded medical directors of the air ambulance program. For each patient chart report, the raters indicated the number of minor, major, and critical errors of omission and commission committed by the paramedics. To determine the strength of the predictive relationship between the various tests and the chart audit errors, we used the Spearman bivariate correlation coefficient.

### Results:

Performance on each of the exams correlated moderately with performance on each of the other exams ( $r = .28$  to  $.35$ ,  $p < .05$ ). However, none of the re-certification evaluations (simulator, written, skills) significantly predicted the number of minor, major, or critical errors of omission and commission committed by the paramedics in the year prior to their re-certification (all  $p$  values  $> .05$ ).

### Discussion:

None of our re-certification exam measures predicted field performance of the flight paramedics, as measured by audits of patient charts. One possible explanation of this lack of correlation is that the various re-certification exam measures might not capture those components of performance relevant to actual patient care. Alternatively, audits of patient charts may not accurately capture field performance by paramedics because of variations between what actions are taken and what is written in a report. Further studies will be targeted towards comparing examination performance to directly observed field performance.

### Reference:

<sup>1</sup> LeBlanc VR, Darling S, & King K (2004). Simulation-based assessments of paramedic performance. *Air Medical Journal*, 23(5), 35.

The psycho/social correlates of using simulated clinical practicum with students enrolled in a baccalaureate nursing program.

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There is a growing body of knowledge on the greater use of simulation in nursing education. Simulation is playing an increasingly important role in skills training. Simultaneously, there is a growing disparity between the supply and demand of nursing due to multiple factors. The current nursing shortage crises pose a significant threat to the nation's health. In 2001, the American Nurses Association (ANA) convened a steering committee of national nursing organization representatives to develop a comprehensive strategy through the nursing summit. The summit, a Call to the Nursing Profession, envisioned what nursing should look like, and where it should be, by the year 2010. Desired outcomes were determined in 10 domains. This abstract proposal addresses selected portions of the education domain. Specifically, within the education domain, the summit calls for the establishment of magnet models or centers of excellence in education, and well as demonstration of new education models and partnerships. This abstract presents the use of one such model, the use of simulated clinical practicum. The abstract contains a proposed model of simulated clinical practicum which is being developed, in part, to fulfill the requirements for a PhD from Drexel University. Both presenters are faculty at Drexel University, College of Nursing & Health Professions.

## SIMULATION-BASED CRISIS TRAINING FOR PAIN MANAGEMENT SPECIALISTS

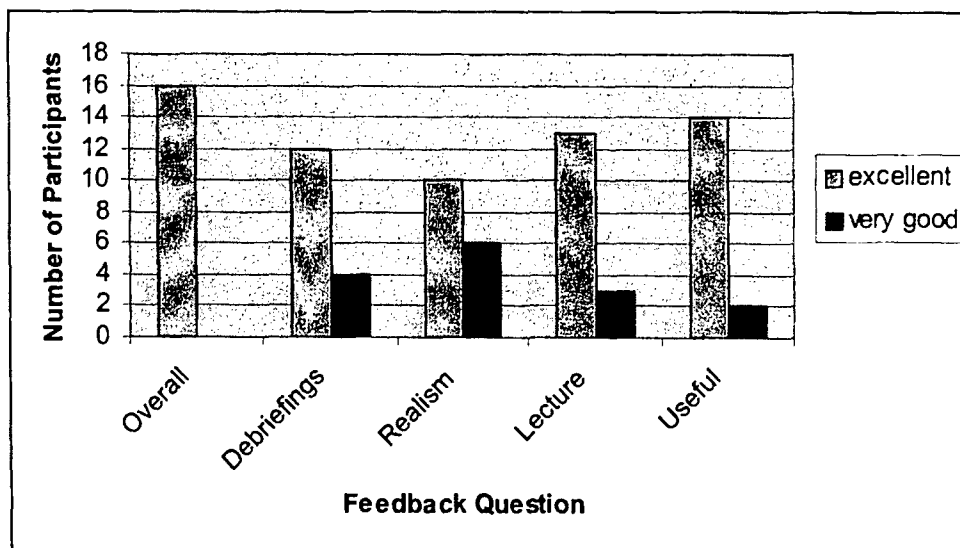
GJ Brenner<sup>%</sup>; RV Joshi<sup>%</sup>; DB Raemer<sup>\*%</sup>

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**Introduction:** Procedures utilized to treat patients with acute and chronic pain complaints have known complications that, while uncommon, can be life-threatening. Pain management specialists often practice in out-patient centers that may not be particularly conducive to managing acute emergencies. While some pain management practitioners may be anesthesiologists who are well versed in resuscitation and acute care management, others come from disciplines such as neurology, physiatry, and psychiatry in which training in managing emergent events is less complete. In addition, some of the anesthesia trained pain specialists have not practiced in the operating room or critical care setting for some time and may feel "rusty" in their acute management practice. Thus, we developed a course to teach the principles of crises management in the setting of the pain clinic.

**Methods:** Goals of the course include recognizing acute complications, calling for help, airway management, and teamwork in a pain management context. Scenarios were developed that are likely complications in a pain clinic setting such as medication errors, injection into unintended compartments (e.g., intrathecal or intravascular), and anaphylaxis. The trainees participate as both individuals and as a team for three scenarios. After the first scenario, the trainees are given a didactic lecture on the principles of CRM. Each scenario is videotaped and the participants hold a debriefing facilitated by a trained CMS faculty member and an expert pain management physician (anesthesiologist). Course quality and acceptance were reviewed with a post course survey using a five-point Likert scale. Open comments were also encouraged.

**Results:** A total of 16 trainees participated in four of the pilot training courses to date. Eight trainees were attending level and eight were fellows. As shown in the plot, all responses to the feedback questions were either excellent or very good. Sample comments include: "Very helpful preparation for when 'stuff' happens", "I would like to participate again", and "They are still mannequins"



**Conclusions:** A highly self-rated course in crisis management for pain management specialists has been created to teach acute emergency skills during procedures. We plan to expand the availability of this course to other pain practitioners in our region. We are also expanding the program to teach basic injection technique to beginning pain fellows and to improve difficult physician-patient interactions (e.g., dealing with an aggressive, drug-seeking individual).

**Evaluating the Use of Advanced Patient Simulation in Training for Final Year UK Medical Students in the Recognition of the Acutely Ill Patient, Immediate Management Strategies, and Resuscitation Skills.**

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**Trent Simulation & Clinical Skills Centre, Queen's Medical Centre, Nottingham, UK**

The Resuscitation Council (UK) and Intercollegiate Board for Training in Intensive Care Medicine in the UK have initiated a national project to identify core knowledge and skills required by health care students in order to provide safe care for acutely ill patients in the hospital setting. We wished to evaluate whether a combination of two separate training days, i.e. ILS (Immediate Life Support) and ALERT (Acute Life Threatening Events – Recognition and Treatment), was complementary for teaching final year medical students about life support skills and care of acutely ill adult patients, and whether this could be enhanced further by using advanced patient simulation training.

Eighty students attended consecutive ILS and ALERT courses during the final period of their undergraduate training, followed within a few weeks by a structured training day in the Simulator Centre aimed at putting their knowledge and skills into practice under observation during specific scenarios. These scenarios were filmed and debriefed fully with input from the whole group in attendance. Each day was evaluated by the students and trainers using a structured questionnaire. In addition the students were required to develop a personal action plan to identify key knowledge and skills that they felt required further attention during their further education and training in the workplace.

Each training day received extremely positive responses in terms of meeting the students' expectations and that such training should be compulsory within the undergraduate curriculum. Participation in realistic scenarios in the Simulation Centre was identified as the most beneficial component of the training, along with the feedback provided during the advanced simulation-training day. This constructive debriefing allowed weaknesses in specific technical skills, aspects of team working, communication, and decision-making skills to be identified and discussed in a focussed manner, and students felt better enabled to seek further support and training in these issues when back in the clinical environment.

This combined training programme is complementary and needs to be established within the final undergraduate year of medical student training. The opportunity to put into practice key aspects of the knowledge and skills in the Simulation Centre identifies the difficulties likely to be encountered when in the clinical environment, which otherwise would not have been apparent to the students. Development of a personal action plan encourages the student to pursue specific further training based on their own identified needs, and is likely to be more applicable and achievable when back in the clinical environment.

# Development of an organisational model for critical care interprofessional simulation training

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**Introduction:** The aim of this abstract is to present how we are intending to implement the use of simulation in the undergraduate curriculum of our final year healthcare programmes. Interprofessional education is currently prominent in the UK Department of Health's (DH) agenda for the education of Health Professionals (DH, 2000). In addition to common subjects studied interactively in classrooms and in practice, we are currently developing multidisciplinary critical care scenarios for simulation-based training. The professional groups involved in this development include (initially) volunteer undergraduate students from adult and children's nursing (372+65), midwifery (42), paramedic sciences (60), radiography (130), and physiotherapy (100), as well as trainee doctors from other institutions.

**Method:** Running realistic scenarios with large number of students from different specialties is a particular challenge and requires special attention. Until recently very few lecturers from the allied health professions have been involved in our simulation training. This implies that a number of them need to be trained in order to become facilitators of the sessions and to coach students appropriately.

The large number of students registered on the programmes involved has meant that even to run a pilot with volunteer students, special attention has had to be paid to the number of students attending each session. In order to maximise the effectiveness of each of the 3-hour simulation sessions organised we decided to invite students in groups of 20. This will include 6 nurses/midwives, 4 physiotherapists, 4 radiographers, 4 paramedics and 2 trainee doctors. Half of the students would at any one time take part in a scenario or wait to be called upon for help in an adjacent room, while the other half stay in the observation room observing the scenario. Over the scenarios students will rotate between the simulation platform and the observation and debriefing room. This allows all students to benefit equally from the simulation practice and debriefings. To ensure that students remain focused throughout the session, a lecturer from each discipline needs to be present to help them to analyse the scenarios from the observation room, and to answer their questions. Overall we are anticipating involving up to 5 lecturers per session in addition to the patient simulator operator. Post-participation in the scenarios, all students will reflect on their experience and consider the transfer of what they have learnt into practice.

**Conclusion:** Previous experience leads us to expect positive results from this pilot interprofessional teaching and learning approach. Feedback will be collected from both students and facilitators who decide to opt in to these sessions. Since students in the observation room will be of different disciplines and will be observing their mixed group of peers taking part in scenarios, we think that they will benefit from that experience by gaining a deeper understanding of their individual roles as part of the care team and the potential to improve their collaborative practice and the quality of patient care.

## References:

Department of Health, 2000. Investment and Reform for NHS Staff – Taking Forward the NHS Plan. HMSO, London.



## **The Oxford Simulation Apparatus for Flexible Endoscopy (OxSAFE)**

**Dr MW Lim** 1, Dr SW Benham 1, Dr AW Fitzgibbon 2, Prof JW Sear 1

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**Introduction:** Managing the difficult airway is a crucial anesthetic skill. A frontline device to facilitate this is the intubating fiberoptic bronchoscope. However, the incidence of the difficult airway is low (1 in 3000 general population), making it unsuitable for traditional training and skill maintenance methods. A number of low- to high-fidelity simulators have been developed to address this need. However, low-fidelity simulators are unrealistic, while high-fidelity simulators are expensive.

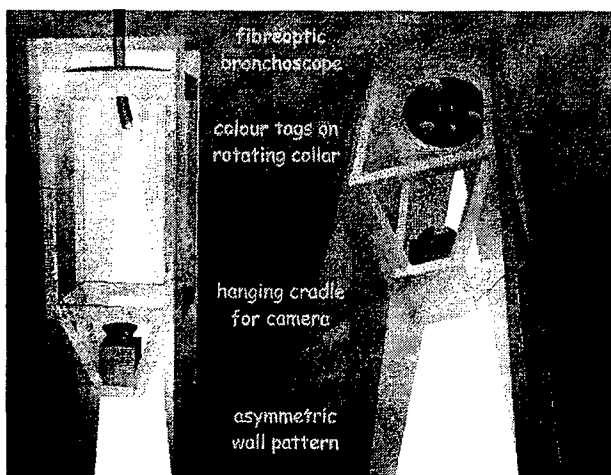
**Hypothesis:** OxSAFE uses recent advances in computer vision, 3D graphics and simulation technologies to build an inexpensive, yet versatile and responsive endoscope-computer link.

**Concept:** Our initial design involved stereoscopic cameras to triangulate the 3D position of the endoscope tip. This was eventually simplified to a single camera system. Our final concept is the hanging cradle concept (see embedded graphic), where the camera is placed at an optimal distance from the endoscope for measuring endoscope stem rotation and tip angulation. Inserted endoscope depth is then derived from the measured width of the asymmetrical wall pattern. The measured parameters are fed into a 3D computer graphics engine, where training scenarios may be simulated.

**Discussion:** OxSAFE is simple and inexpensive, yet elegant and responsive. The inherent advantages of OxSAFE may be further enhanced by an internet library of "virtual-reality" models.

**Conclusion:** We believe that this novel, patent-pending system may become the cornerstone of a new generation of flexible endoscope simulators.

**Acknowledgement:** Dr Lim is supported by a British Journal of Anaesthesia / Royal College of Anaesthetists research fellowship.



The use of a Simulation Information Management System (SIMS) for data mining of simulation sessions.

**John Lutz**, Kimberly Mitchell, John Schaefer III M.D.

The Peter M. Winter Institute for Simulation, Education and Research (WISER)

**Setting:** The Peter M. Winter Institute for Simulation, Education and Research (WISER) is a large academic simulation center based at the University of Pittsburgh. WISER has developed a web based Simulation Information Management System (SIMS) that allows customized surveys, evaluations and quizzes to be completed online by course participants and collect data from the simulation sessions. Each completed form is stored with a unique ID of that user. WISER uses the Laerdal SimMan patient simulator which creates an automated log file of the simulation session. The software that controls the simulator allows for automated data capture, such as when ventilation is detected, as well as a customizable interface that allows end users to record events that happen by simply selecting an item off of a menu, such as when a participant uses a specific airway device. This log file is stored in a standardized Extensible Markup Language (XML) format. Using the SIMS, the session log file can be uploaded into the database and linked to the particular participant for that session.

**Method:** WISER, as part of its SIMS, has developed a Medical Simulation Educational Analysis Tool (MSEAT) to allow the online linking of these online forms to the XML data. Users can select a particular question from a form and then select the criteria collected in the XML data logs from the session. The SIMS will then display the results of the query in both a graphical and tabular format. Links to each session log allow the user to drill down into specific data files to get further information on that session. Different Extensible Style Sheets (XSL) can be applied to the session XML data to provide different views of the data. Digital video recordings of the sessions can be hyperlinked to time specific points in the data so that that a video review of the session can be conducted. As an example, a question on a pre-course survey regarding years of experience can be linked to how often a specific device is used for a certain scenario.

**Results:** Using this new tool, researchers at WISER are able to easily collect data regarding the simulation sessions recorded there. This data is collected as part of the normal teaching process. This process, when coupled with standardized scenarios, offer some significant opportunities:

- Practical collection of real time objective data from simulation encounters
- Real-time standardized performance analysis to support feedback, educational research and quality assurance
- Practical relational data mining that can be coupled with demographic information and survey information (also collected as part of the process) and the opportunity for practical, inter-institutional collaborative data collection for educational research

## **Simulating One-Lung Ventilation: Making a Double Lumen Endobronchial Tube Work with the METI HPS-010 Adult Mannequin**

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### **Introduction**

The METI HPS – 010 adult mannequin has several realistic airway features, including the ability to correctly place a left endobronchial tube with the aid of a flexible fiber-optic scope. While designing a scenario involving one-lung (right) ventilation, we encountered a problem: end-tidal CO<sub>2</sub> measurements were far too low when the double lumen tube was clamped in the usual way for one-lung ventilation. Upon investigation, we found that the reason this occurs is that CO<sub>2</sub> emanates from each lung separately; half the total from each lung. Therefore, we set out to devise a method in which a regular left endobronchial tube could still be used for simulating a one-lung ventilation scenario, without compromising the "reality" of the simulation.

### **Materials and Methods**

The following materials were used in this simulation:

- 1- 35 Fr. Left Endobronchial Tube (Sheridan) and circuit adapter
- 1- 4x4 gauze pad
- 1- Flexible fiber-optic scope with video display

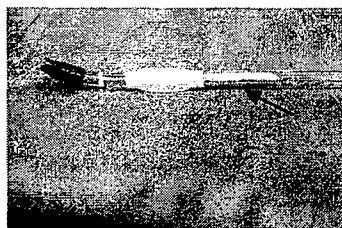


fig 1.



fig 2.

### **Setup**

Use a fiber-optic scope to position a standard 35 Fr. left endobronchial tube with the bronchial lumen in the left mainstem bronchus of the mannequin. The bronchial cuff must remain deflated. This fact is kept hidden from the trainee, and cannot be easily discerned by inspection. Next, a small piece is cut from a 4x4 gauze pad, and tamped down the bronchial lumen (fig 1), far enough down that it cannot be seen from above the mannequin. The usual vent cap on the left side of the tube is opened and a clamp is placed proximal to the open cap, just as it would be with an actual patient. Breath sound resistors are adjusted to silence the left lung and the mannequin turned with its left side up. The breathing circuit is connected as usual (fig 2) and the trainee is allowed to check tube position via the fiber-optic scope down the tracheal lumen of the tube.

### **Discussion**

The modifications that we implemented allowed the proper amount of CO<sub>2</sub> to be measured, thus providing our trainees with realistic visual, hemodynamic and end tidal CO<sub>2</sub> input to analyze their simulated patient's situation. While simulators may not include features to enable all scenarios, these problems can often be overcome with a little creativity, ingenuity and "super glue".

## A touch of added realism: Preparation of your patient simulator for CVP monitoring

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**Introduction:** It is widely accepted that experience is the best acquired "on the job", we all "learn by doing", and that "practice makes perfect". Making simulation training scenarios as realistic as possible is an important issue that has a direct effect on the teaching effectiveness of such training method. The aim of this abstract is to present how we recreated a setup to simulate a patient subjected to Central Venous Pressure (CVP) monitoring. This is a continuation of the tricks that apply to patient simulators and that have already been presented at another conference in order to enhance simulation training such as urinary catheterisation<sup>1</sup> and internal haemorrhage with a wound drain<sup>2</sup>. Work serving a related purpose was also recently presented by Wade et al<sup>3</sup>.

**Method:** The essential components required to perform this modification are: a syringe, a long tube with an internal diameter corresponding to the external diameter of the CV catheter, a CVP manometer scale, and a complete CVP line. In order to directly control the CVP measurement the CV catheter needs to be pushed inside the long tube until it properly covers the lumens. Some silicon or glue is required to prevent any leak while the tube is in place inside the patient simulator. Once secured the modified CVP line needs to be adjusted under the mannequin's skin in the appropriate position<sup>4,5</sup>. The tube needs to be hidden and run as far as the control room where it can be primed with water and needs to be connected to a half filled syringe. The reading on the CVP manometer needs to be adjusted to the required level just before the scenario. Ideally a small syringe should be used by the operator during the scenarios to obtain a better control of the CVP reading. It is important to note that this setup works correctly only when using the port connected to the lumen at the tip of the catheter. The other lumens are blocked by the long tube and require high pressures to operate, which may cause leaks.

**Conclusion:** It is hoped that this abstract will be particularly useful to people starting in the field of medical simulation. We strongly believe that sharing our experiences and practices is the best way to improve healthcare trainees' experience, and ultimately provide better patient care. Although it has been noticed that physicians often underestimate CVP measurement<sup>6</sup> and that the use of CVP manometers is slowly being replaced by more advanced technology, it still is a very valid technique to which trainees should be exposed. This CVP line setup is inexpensive, very realistic, and can be adapted to any patient simulator with a removable chest or neck skin. Students who participated in scenarios making use of this setup found it very realistic.

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## Instructor Qualification Guidelines for Crisis Resource Management

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**Introduction:** Growth in our local medical simulation community has prompted a need for standardization of our center's Crisis Resource Management (CRM) Instructor Qualifications to ensure overall quality assurance across a large, multi-center hospital system. Our simulation center has been providing Anesthesia Crisis Resource Management training for over 10 years and has adapted CRM training to other specialties. The research arm of our hospital system's self-insurer offers insurance premium discount programs associated with CRM training in anesthesia and obstetrics. Our self-insurer supports this standardization to ensure uniform quality of training across its member hospitals.

**Methods:** A committee created guidelines for internal use reflecting our center's CRM orientation and addressed three areas of the certification process: *Obtaining* - becoming a Certified CRM Instructor; *Maintaining* - maintaining Certification; and *Certifying* - formal procedures for granting Certification. The guidelines were unanimously approved by our center's faculty, professional staff, and Board of Directors.

**Results:** Table 1 summarizes guidelines for obtaining and maintaining Certification. The complete guidelines are available on our center's website.

**Discussion:** Creation of these guidelines, we believe, will enable our CRM training programs to have qualified instructors and will help ensure the quality and consistency of courses. This model of standardization may be a viable blueprint for other centers looking to standardize the training and qualifications of their CRM instructors.

**Table 1. Abbreviated Guidelines for Qualification of CRM Instructors**

Obtaining Certification	
<b>Prerequisites:</b> Advanced degree/experience.	
<b>Desired state:</b> Ability to plan, lead, and implement a CRM training course.	
<b>Time requirement:</b> Approximately 8.5 to 10 working days generally completed within one academic year.	
<b>Criteria:</b> Participate in CRM courses; complete instructor debriefing workshop; work as an assistant debriefer; work as a lead debriefer; provide didactic lecture on CRM; work as a course director; create a simulator scenario; be familiar with simulation technology; evaluation of videotaped debriefing by a qualifying committee; demonstrate knowledge base in areas relevant to CRM. Certification will be for three years.	
Maintaining Certification	
<b>Prerequisites:</b> Certification as CRM Instructor.	
<b>Desired state:</b> 1. Instructors will be able to plan, lead, and implement a CRM training course; and 2. Instructors will demonstrate a professional commitment to integrating and improving behavioral-based and human factors training in medicine.	
<b>Time requirement:</b> Minimally six days per academic year.	
<b>Criteria:</b> <i>Course Conduct:</i> Be a lead instructor for at least four CRM courses annually; participate in post-course faculty and staff debriefing; self-critique after each course; be able to integrate behavioral and human factors issues into scenario debriefings; have at least one debriefing videotaped and reviewed by two other certified Instructors. <i>Professional Growth:</i> It is the responsibility of all Instructors to undertake a process of improving instructional skills and subject matter knowledge. This can be accomplished by various methods, e.g., literature reviews, research meetings, retreats, organized conferences, participating in our center's instructor courses and governance committees.	

**Summary:** Growth in local medical simulation prompted a need for standardization of our center's Crisis Resource Management instructor qualifications; internal guidelines were created. Instructor standardization helps ensure course quality and consistency, and could serve as a model for other centers.

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**Does Communication-training in Anesthesiology Improve Patient Safety?**

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**Background and Goal of Study**

Human factors are relevant sources for anaesthesia mis-haps. Currently there is no concept bringing mandatory human factors training to anaesthesia education and training. However, data from other high-risk domain suggest that the quality of communication influences the quality of incident management. Therefore, communication training is a means to improve patient safety. The aim of our study is to test whether a training that combines psychological briefing with simulated critical incidents improves anaesthetists abilities to cope with perioperative critical incidents better than simulator skills training alone.

**Materials and Methods**

34 residents had to cope with one out of three scenarios at the anaesthesia simulator. The treatment group (TG, n=20) was given a two-hour training session on communication before going to the simulator. The control group (CG, n=14) received a lecture on human factors. The simulator-session was videotaped. Medical management was evaluated by anaesthesia staff, communication by experienced psychologists. Both were double-blinded. Interrater reliability was high (70-85%). Follow-up interviews were recorded two months later.

**Results and Discussions**

A significant correlation between quality of medical management and team-communication was found ( $r=0.57$ ,  $p=0.001$ ). Communication in the TG was more initiative ( $p=0.001$ ) and resulted more often in conflict situations with the surgeon ( $p=0.08$ ). In the interviews, the TG remembered more "lessons learnt" ( $p=0.08$ ) and reported significantly more behavioural changes due to the training ( $p=0.08$ ).

**Conclusion(s)**

Medical management can be improved by proper team communication. Combined medical/psychological training is superior to medical-skills training alone in coping perioperative critical incidents. Combined training should therefore be part of the striving for patient-safety.

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Submitted to the International Meeting on Medical Simulation (IMMS) 2005

### **A behavioural marker system to rate surgeons' non-technical skills**

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**Objective:** Analyses of adverse events in surgery reveal that many underlying causes are behavioural, such as communication failure<sup>1</sup>, rather than technical. Behavioural marker systems are used to train and assess non-technical skills in other domains such as civil aviation and anaesthesiology<sup>2</sup>. No such system currently exists for surgery. This poster describes the development of an empirically based skills taxonomy and behavioural marker system to structure observation and feedback on surgeons' non-technical skills.

**Research design:** The prototype system was developed according to a systems design model and was based on cognitive task analysis (Critical Incident interviews) with 27 consultant surgeons in general, cardiac and orthopaedic surgery in Scottish hospitals. The interviews were coded and a multi-disciplinary group of surgeons and psychologists used an iterative process to develop a skills taxonomy. This was supported by other methods including an attitude survey, literature review, analysis of surgical mortality databases, and observations in theatre.

**Results:** A number of core categories and elements of non-technical skills were identified in the analysis including situation awareness, decision making, task management, leadership, teamwork, and communication. These were structured into category & element levels and observable behaviours (markers) indicative of good and poor performance were developed for each element by three independent panels of surgeons to form a prototype behavioural marker system. Details of the prototype system will be presented at the meeting.

**Conclusions:** The skills taxonomy and marker system presented here were empirically grounded in surgery, can be used to structure feedback in the operating room or simulator, and guide non-technical skills training. This reliability of this system is currently being tested using standardized scenarios filmed in operating rooms and an operating room simulator.

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### **Acknowledgements**

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**Title:** UTILIZING SIMULATION TO COMPARE THE STANDARD PEDIATRIC CODE CART WITH A PEDIATRIC CODE CART BASED ON THE BROSELOW TAPE

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**Background:**

The response time of healthcare providers in a pediatric code is critical to patient survival and access to resuscitation equipment is a key component in delivering optimal care in code situations. Historically, children's hospitals and clinics use a standard pediatric code cart ("standard cart") in which drawers are organized by intervention (e.g. intubation module, IV module), requiring multiple drawers to be opened during a code. In addition, the equipment in each drawer must be sorted in order to find the appropriately sized equipment for the patient undergoing resuscitation. Most Emergency Departments, however, utilize a pediatric code cart based on the Broselow tape ("Broselow cart") in which each drawer is color-coded and organized by patient length and weight ranges; each drawer contains all necessary equipment for resuscitation of a patient in that specific weight range. Literature review revealed no studies examining the utility of either cart.

**Objectives:**

To assess which code cart organization (standard versus Broselow) allowed for

1. Faster access to equipment
2. More accurate selection of appropriately sized equipment
3. Better user satisfaction

**Methodology:**

We performed a prospective, randomized, controlled, cross-over trial in which 21 pediatric healthcare providers were assigned the role of obtaining the appropriate equipment during 2 standardized, simulated codes alternately utilizing the standard cart or Broselow cart. The time required to find appropriate medical equipment during the code was measured. After the simulated codes, subjects completed a questionnaire assessing the perceived ease of use of each cart and cart preference. All simulations were performed in the Center for Advanced Pediatric Education at Stanford, a physical space designed to replicate the real medical environment with the technology to allow for videotaping of scenarios.

**Results:**

Of the 21 subjects, 10% had prior experience with the Broselow cart versus 62% with the standard cart. 62% of subjects found the Broselow cart "Easy" or "Very Easy" to use versus 33% for the standard cart. Of the 21 subjects, 67% preferred the Broselow cart, 10% preferred the standard cart, and 23% indicated no preference. In addition, correct equipment was provided 99% of the time with the Broselow cart versus 83% with the standard cart. Times required to find the appropriate medical equipment are included in the Table below.

Mean Time (seconds +/- SD) to Obtain Appropriate Medical Equipment			
	Broselow Cart	Standard Cart	p-value
Intubation Supplies	29.1 +/- 12.0	38.7 +/- 13.5	0.03
Intravenous Catheter	26.1 +/- 14.2	20.5 +/- 16.1	0.23
Nasogastric Tube	20.0 +/- 18.1	38.2 +/- 28.1	0.03
Suction Catheter	15.4 +/- 11.4	17.2 +/- 14.2	0.70

**Conclusions:**

Despite less prior experience with the Broselow cart, subjects in this pilot study found it easier to use and preferred it over the standard cart. In addition, subjects located intubation equipment and nasogastric tubes significantly faster using the Broselow cart, and correct equipment was provided more often with the Broselow cart. These data suggest sites caring for pediatric patients should consider modeling their code carts after the Broselow cart to enhance provider confidence and patient safety.



**Introduction:** Many healthcare organizations have been promoting a high reliability organizational (HRO) culture (1-2). An important characteristic of HROs is that everyone has an obligation to independently stop an ongoing process when they believe there is an issue of safety or quality (3). In aviation, the concept of the "two-challenge rule"(4) has been institutionalized. The gist of this rule is that if a pilot puts the aircraft in an unsafe condition, the subordinate is to challenge the action two times if necessary. If no answers or if nonsensical answers are provided, the subordinate is empowered to take over the controls. We thought the two-challenge rule might have importance in healthcare and have been teaching skills for challenging others when issues of patient safety arise. We examined responses of anesthesia residents when exposed to an attending physician's ineffective, questionable or unacceptable practice.

**Method:** In a simulated OR, an anesthesia attending (confederate) is supervising a senior resident (trainee) during elective surgery. It is understood that the patient already has a regional block in place and the plan is to induce general anesthesia. Just before the general anesthetic is administered, it becomes known that the patient had orange juice within the last two hours. With pressure from the surgeon to proceed, the attending eventually decides to use rapid sequence induction and orders the resident to proceed with the general anesthetic (administration of STP, EVENT 1). After surgery commences, the patient develops new-onset atrial fibrillation. The attending orders volume and amiodarone (EVENT 2) with no significant benefit. The attending then orders the resident to administer adenosine (EVENT 3). After a long cardiac pause, the attending administers chest thumps. After re-establishing a heart rhythm (still A-Fib), the attending orders the resident to administer another dose of adenosine (EVENT 4). The scenario was conducted eleven times. An investigator (anesthesiologist) analyzed videotape records of the scenarios. Every attending-resident exchange was characterized as to the degree of resident reluctance (agree, neutral, disagree, or disagree effectively (defined as refusing to assist and calling for help)) to proceed with ineffective, questionable or unacceptable practice.

#### Number and Type of Resident Responses to Attending Physician Actions and Orders (n=11)

Event #	Agree	Neutral	Disagree	Disagree effectively
#1 (to STP)	23	3	8	0
#2 (Amiodarone)	35	17	36	0
#3 (Adenosine 1)	21	7	18	0
#4 (Adenosine 2)	20	6	20	5 (2 cases)
Total	99	33	82	5
Percent	45%	15%	37%	2%

**Conclusion:** Although there were strong indications that residents disagreed with the treatment advocated by their simulated attending, there were relatively few effective challenges. This suggests the educational value of teaching the two-challenge rule to healthcare providers. We believe that when the two-challenge rule is understood and implemented throughout healthcare, it will enhance patient safety.

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## Personality and attitudinal influences on team-based behaviour in medical work groups

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This presentation will review current and recent research conducted at the University of Texas Human Factors Research Project relating to psychological influences on the behaviour of physicians and nurses. Studies are being conducted in the two broad areas of attitude and personality as they relate to medical practice. Past research in non-medical, socio-technically complex work settings has suggested that both attitude and personality influence behaviour in team settings. Attitudes generally refer to beliefs that are at least partially subject to modification through training and education while personality tends to be more fundamental in nature and far more resistant to change. Results from both lines of investigation will be presented.

Attitudinal assessments, conducted through self-report surveys completed by healthcare practitioners, have identified several key issues relevant to team behaviour and training. Data from multiple institutions will be presented showing that anesthesiologists and surgeons consistently demonstrate opposing views as to which specialty is ultimately responsible for patient well-being in the operating room. Several interpretations of this finding are possible, including the dual nature of authority in that setting. However, a key issue appears to be the potential for conflict between these two groups when anesthetic and surgical priorities differ. Other findings to be presented include a high incidence of self-reported error among practitioners, a general mistrust of administration efforts to reduce error, and an increase in that distrust following experience with patient litigation. Such findings suggest that practitioner-lead efforts to reform medicine are likely to be more readily embraced by front-line personnel.

Personality research to be presented includes character trait assessments of both European and North American physicians spanning a period of several years. Instruments used to assess personality include the NEO Five-Factor Inventory (NEO-FFI), developed by Costa and McCrae which assesses the five broad constructs of *neuroticism*, *extraversion*, *openness to new experience*, *agreeableness* and *conscientiousness*, and the University of Texas Personal Characteristics inventory (UT-PCI) developed by Helmreich, which assesses both positive and negative facets of *instrumentality* (or achievement motivation) and *expressivity* (or social competence). Our first series of analyses has examined the relationship between shared personality characteristics and the nature of professional and specialty culture. Results show that physicians tend to share high levels of achievement motivation with other high performance populations that we have studied, including astronauts and commercial pilots. However, there appear to be specialty-specific trait profiles, suggesting that some aspects of professional culture are partly personality based. Our more recent investigations have begun to examine the relationship between personality and stated attitudes. Early findings suggest that some commonly assessed teamwork attitudes are highly personality dependent. This finding suggests that such attitudes may reflect underlying trait dispositions and may be highly resistant to standard team training approaches.

Future studies will need to examine the relationship of both personality and team attitudes to actual behaviour in medical teams. Medical simulations, particularly those involving multidisciplinary teams are an ideal venue in which to conduct such studies. The findings from such research promise to inform two broad areas of healthcare: The selection of medical and residency applicants and the design of future training programs aimed at improving teamwork and reducing error in healthcare teams.

**Acute Medicine Unit Senior Nurse Development Day: Combining dynamic advanced patient simulation scenarios and static clinical knowledge and skill-based exercises to meet training needs for senior staff.**

**James Avery and Bryn Baxendale**

**Trent Simulation & Clinical Skills Centre, Queen's Medical Centre, Nottingham, UK**

Queen's Medical Centre (QMC) is a large acute NHS Teaching Hospital that has recently opened an Acute Medicine Unit (AMU) in order to improve the admission process for acutely ill adult medical patients. This coincided with the need for existing medical and nursing staff to adopt new working patterns and relationships, along with working more effectively with healthcare teams from other areas of the hospital. Traditionally it has been rare to offer multiprofessional training to staff groups from different clinical areas, and this was highlighted as a potentially significant risk to safe patient care when the AMU opened. In addition, we felt there was a deficit in appreciation of human factor training within the senior nursing staff who would be leading the AMU on a daily basis. Hence we designed a development day to explore issues of leadership, team working, decision-making under stress, and communication skills for this staff group, and which also would identify group and individual learning needs in respect of specific skills and clinical application of knowledge.

A participant held assessment framework was devised to cover activity during and beyond the development day. This contained eight clinical and leadership based learning objectives and prompted the participant, by reflective practice and appraisal to develop further needs based objectives and action plans.

A group of 7 senior nursing staff attended the day. After orientation with the simulation training environment, the group allocated themselves into teams with a specified co-ordinator and received a 'ward handover' that presented several patient details. The teams then entered the simulation room to commence their working shift, and were tasked with looking after two simulated patients (both manikins). Each 'patient' scenario gradually increased the pressure on the participants individually and as a group in order to stretch the boundaries of their clinical knowledge and usual responsibilities. This session ran for about 30 minutes after which a full team debriefing was facilitated using video playback. The group rapidly identified issues among themselves related to leadership and co-ordination, task management, effective communication strategies, and management of conflict in a stressful chaotic clinical environment. Beginning the personal action plans clarified several areas of need in terms of applying knowledge in the acute clinical setting and unfamiliarity with certain skills and procedures that might be commonplace in the AMU.

The remainder of the training day focussed on several of these identified needs including interpretation of invasive haemodynamic monitoring values, fluid management, drug delivery, non-invasive ventilation, and team organisation issues. This employed a variety of dynamic and static scenarios within a clinical skills training room, using either an advanced patient manikin or other 'part-task' training devices. The scenarios were a continuation from those employed earlier in the day, which maintained a degree of realism for the participants.

Participants identified unexpected training needs among themselves including many 'non-technical' skills. Evaluation following the day using a Likert scale demonstrated an increase in confidence in performing clinical assessments, instituting an intervention, and also participants felt strongly committed to recommend this type of training day to their peers as an innovative means of technical and non-technical skill development. As facilitators, with greater understanding of the scope of skills interdependency, the event has shaped the content and delivery of meeting future educational needs.

## **Simulation Training in Emergency Preparedness (STEP): A Statewide Weapons of Mass Destruction (WMD) Training Program For Hospital Personnel**

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**Marc J. Shapiro, MD; Selim Suner, MD, MS; Leo Kobayashi, MD;**

**Kenneth Williams, MD; Francis Sullivan, MD; Gregory Jay, MD, PhD.**

**From the Department of Emergency Medicine, Brown Medical School, Providence RI**

**Objectives:** To create and implement a statewide educational program featuring advanced medical simulation for training of civilian hospital-based personnel in recognition and treatment of weapons of mass destruction (WMD) injuries.

**Description:** The Rhode Island Hospital Medical Simulation Center (RIHMSC) contracted with the State of Rhode Island to provide disaster response training for hospital medical personnel. This program was an educational component of the state's "Bioterrorism Hospital Preparedness Program" funded by Health Resources and Services Administration (HRSA). A consensus panel of regional disaster experts and simulation faculty developed the course curriculum. The one-day course consisted of 1) lectures covering biological, chemical, radiologic agents and incendiary devices, 2) debriefing of actual video footage from Tokyo sarin release, 3) practical training on Level C Personal Protective Equipment (PPE) and 4) multiple simulations of biologic and chemical weapons scenarios using Laerdal SimMan<sup>TM</sup> manikins and PPE.

Advanced medical simulation techniques were used to re-create Emergency Department (ED) and Intensive Care Unit (ICU) settings. Three simulation scenarios were generated: a) ED patient presenting with syncope and viral symptoms from smallpox, b) ED patient injured by an explosive device dispersing a cholinesterase inhibitor payload, and c) ICU patient with tularemia sepsis. Multi-disciplinary teams of 2-4 participants, using PPE as necessary, were required to manage the patients while addressing WMD concerns relevant to a hospital setting. All scenarios were video-debriefed with respect to decontamination, agent identification, PPE use, patient management and hospital response.

86 participants comprised nurses (n=55), physicians (n=15), respiratory therapists (n=4), Emergency Medical Technicians (n=2) and other staff (n=10) from nine hospitals and were trained over five months. An additional forty Internal Medicine residents underwent half-day sessions with all three simulations as part of a Centers for Disease Control grant. 102 (87.9%) of 116 survey respondents rated the program to be "excellent," 14 (12.1%) as "good."

**Conclusion:** A focused multi-modality training program for weapons of mass destruction event preparedness was constructed and executed. Regionally standardized educational content and advanced medical simulation were incorporated into a training program to prepare hospital personnel for potential terrorist incidents.

Title: Addressing the Systems-Based Practice Core Competency: A Simulation-Based Curriculum

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Abstract: Systems-Based Practice (SBP) is one of the six core competencies by which resident performance are evaluated. Emergency Medicine specific SBP criteria have been described addressing issues pertinent to EM practitioners. We describe a simulation-based assessment tool to address this core competency.

Methods: We present a simulation-based curriculum focusing on the Systems-Based Core Competency. We have devised cases that address EM specific Systems-Based Practice issues of relevance. The format incorporates:

- 1) Direct observation of the resident managing the case and performing critical actions by both attendings and co-residents.
- 2) Checklist evaluation of the competency specific criteria.
- 3) DVD format videotaping of the encounter to be placed in the resident's Educational Portfolio.
- 4) Debriefing session with resident including didactic and/or testing of the material.

Results: Overall resident satisfaction with the simulations on initial trials was high. The residents participated either as a primary manager of the case or as observers of the simulation-enhanced case-conference. The debriefing sessions for the residents solidify the relevant points of the case and fill in the knowledge gaps that may not have been addressed directly in the management session.

Conclusion: Systems-Based Practice Simulation cases conducted over the course of a residency class' post-graduate training exposes residents to the Systems-Based Practice issues relevant to Emergency Medicine. Residents participate in a case-conference based format that has been enhanced by the realism of high-fidelity simulation. We believe this format is an innovative method with which to teach this Core Competency.

## USING SIMULATION TECHNOLOGY TO PRODUCE AN EDUCATIONAL VIDEO: EXCELLENCE IN END-OF-LIFE CARE IN THE PEDIATRIC INTENSIVE CARE UNIT

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### Introduction

Providing competent and compassionate end-of-life care is an essential component of patient care. Still, little formal training exists surrounding this issue. To address this deficiency in training, we have utilized simulator technology to produce an educational video teaching pediatric critical care clinicians illustrating the process of end-of-life care including withdrawal of the ventilator and conversations with the family that typically occur.

### Methods

A multidisciplinary committee comprised of critical care physicians, nurses, psychosocial staff and educators wrote the script and learning objectives for each scene. Clinicians, paid professional actors, and the PediaSim human patient simulator played the roles of the primary care team, parents, and the patient, respectively. The video equipment installed in the simulator suite was used to record video footage.

### Results

An educational video was produced, entitled "Excellence in End-of-Life Care," to demonstrate the essential components of competent and compassionate palliative care when foregoing of mechanical ventilation. The video was divided into four distinct scenes during which the clinicians, actors, and human patient simulator simulated a team meeting, a family meeting, withdrawal of the ventilator, and a family meeting after death. On the videotape, each scene was preceded with a text list of learning objectives. The Team Meeting scene involved a critical care attending, fellow, and nurse discussing a range of issues including: the patient's condition and family readiness to proceed with withdrawal of life-sustaining therapies, assessing and treating pain; the distinction between palliative care and euthanasia; the use of paralytics; terminal extubation and terminal wean options; and rewriting orders. The Family Meeting scene portrayed a psychologist, critical care attending, fellow, and nurse preparing the family through explanation of the procedure for withdrawing the ventilator, how pain would be assessed and treated, the possibility of agonal respirations, and incorporating the family's wishes and preferences during this time. The Withdrawal of Support scene illustrated the actual process of withdrawing the ventilator from the human patient simulator and clearly denoted the specific responsibilities and roles of the nurse and physician including the removal of catheters and intravenous lines, administration of pain medication, supporting family members, and declaring death. Finally, the After Death scene demonstrated the care team assisting the family with next steps including discussion of autopsy, the possibility for organ donation, arranging for burial, and offering anticipatory grief counseling and support.

### Conclusion

In order to address a gap in training surrounding end-of-life care, an educational video entitled "Excellence in End-of-Life Care" was produced using simulator technology. The video provided a framework of topics to be included in end-of-life care and conversations with families, and simulated the procedure of withdrawing the ventilator. Learning objectives at the beginning of each scene offered guidelines for best practice, and videotaped simulations illustrated an approach toward achieving those objectives. To increase the number of critical care practitioners familiar with end-of-life care and issues, the video will be incorporated during orientation for new hires including nurses, physicians, and support staff.

## Using Simulation Based Learning Systems to Train a Large Urban EMS Service in Difficult Airway Management

Thomas Dongilli WISER

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**Introduction:** The use of simulation-based learning systems to assess and evaluate paramedics is novel. Using a combination of on-line curriculum, the City of Pittsburgh, Bureau of EMS Difficult Airway Algorithm and simulation-based workshops; we were able to train and evaluate 174 City of Pittsburgh Paramedics in management of a variety of difficult airway scenarios. The goal was to assess the comfort level and working knowledge of the paramedics using the Bureau of EMS Difficult Airway Management Algorithm. This was accomplished by comparing pre-course and post course surveys.

**Methods:** All of the training took place at The Peter M. Winter Institute for Simulation Education and Research (WISER). The training course included three hours of self paced on-line and traditional classroom difficult airway management curriculum. An additional four hours of simulation-based training exercises and scenario training was conducted at WISER. The workshop component included review of the Bureau of EMS Difficult Airway Algorithm, a review of difficult airway techniques and rescue airway devices. Each paramedic crew was given a series of six difficult airway scenarios (two pre-course scenarios and four post course scenarios). To maintain a high continuity of instruction, the paramedic instructors were guided by on-line curriculum that allowed for greater uniformity throughout the program. Assessment of the paramedic's performance was traced through a pre-course and post course survey utilizing a web-based program completed by each trainee.

**Results:** The Bureau of EMS Training Division with assistance from the WISER Staff trained 174 paramedics in Difficult Airway Management. Each paramedic crew received six scenarios with a total of 522 scenarios being run. Pre-course and post course surveys were completed on-line. The paramedics reported a 21% improvement in their knowledge of the Difficult Airway Algorithm. Additionally, 11% of the paramedics reported their knowledge of the Difficult Airway Algorithm was such that they could apply it clinically without having to think about it. This education methodology was enhanced by a 99% completion rate of the surveys, with all but one paramedic trainee completing both pre-course and post course surveys.

**Conclusion:** Using a combination of pre-course and post course surveys and simulation-based training exercises, we were able to evaluate performances and attitudes of paramedics based on knowledge and technical skills in the Difficult Airway Management. This model was well received and demonstrated improvement in the paramedic's knowledge of the Difficult Airway Management Algorithm. The analysis of scenario data and clinical experience is also being reviewed.

**Introduction:** VIMA (Volatile Induction and Maintenance Anesthesia) can be performed with sevoflurane<sup>1</sup>. During VIMA, intubation can be performed without intravenous muscle relaxant<sup>1</sup>. The purpose of this study is to determine how the time available for intubation differs between spontaneous ventilation and apnea. The method of comparison is computer simulation. Criterion for "available for intubation" was that the VRG (Brain) anesthetic tension was between 2 MAC and 1 MAC, with intubation begun when VRG reached 1 MAC.

**Methods:** Gas Man® (Version 3.1.8, Med Man Simulations, Inc., Chestnut Hill MA <<http://www.gasmanweb.com>>)<sup>2</sup>, a validated simulation<sup>3</sup>, was used as follows. The breathing circuit was primed by selecting Sevoflurane and Semi-Closed circuit. FGF (fresh gas flow) was set to 4 LPM Oxygen, and VA (alveolar ventilation) was set to 0. A bookmark set at 3 minutes paused the program after circuit priming. For Vital Capacity Induction, VA was set to 40 LPM and the simulation was run for 1 breath by clicking Continue immediately followed by Pause. Then, VA was set to 4 PLM and the simulation was continued. Anesthetic administration was paused when VRG tension reached 2 MAC (4.2%). The simulation was then saved under two names, Apnea and Breathe. Both saved simulations were opened, viewed as tiled, and run until they automatically paused at the time the simulations had been saved, when VRG = 2 MAC. Apnea was simulated by switching circuit to Open and setting VA = 0. Breathe (breathing during intubation) was simulated by switching circuit to Open and leaving VA = 4 LPM. The simulations were run until VRG fell from 2 MAC to 1 MAC (2.1%) The times to reach this level under the conditions of breathing and apnea were recorded,

**Results:** At the end of circuit prime, Inspired Tension = 6.21%. During induction, VRG reached 2 MAC at 10' 29", 7' 29" after circuit prime. During intubation, with Breathing, VRG tension fell to 1 MAC at 13'55", leaving 3' 26" of intubation time. With Apnea, VRG tension fell to 1 MAC at 22' 21" leaving 11' 52" of intubation time. The difference in time available for intubation was 8' 26".

**Conclusion:** Computer simulation with Gas Man shows that available time for intubation during Sevoflurane VIMA is extended by 8' 26", from 3' 26" to 11' 52", by performing intubation during apnea rather than continued breathing.

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## **Trauma and Awareness**

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### **Introduction**

A recent JCAHO alert inspired this simulation using a human patient simulator (HPS) and standardized patient (SP) to prepare trainees to manage patient awareness during general anesthesia. Each of the three distinct scenarios has specific learning objectives.

### **Methods**

In each scenario certain residents were chosen as participants while the remainder were observers.

Part I: A male (HPS) comes to the E.D. after a motorcycle crash with open femur fracture, encapsulated spleen laceration, and pneumothorax. Learning objectives are recognition and treatment of pneumothorax with a patent airway and ATLS review.

Part II: He arrives in the operating room intubated with invasive monitors and IV access. During repair of the open femur fracture, the patient develops acute, profound hypotension. Learning objectives include differential diagnosis of hypotension in this setting, use of CRM principles, and treatment including discontinuation of the inhaled anesthetic. Once the anesthetic is lightened, the orthopedic surgeon and trauma surgeon argue, making inappropriate comments regarding the patient. The trainees should recognize and manage this conflict while caring for the patient.

Part III: An SP is now the trauma victim, recovered in the anesthesia clinic. He has evidence of post-traumatic stress disorder due to recall from his surgery. Trainees interview the patient while the group watches via closed circuit television. Learning objective is appropriate interaction with a patient with awareness. A discussion about awareness and recall followed the simulation

### **Results**

All seventeen senior anesthesia residents who participated in this simulation rated the experience highly. (Overall session rating 4.82/5 +/-0.39) The realism of the HPS was not rated as highly as usual, (HPS=3.82/5 +/- 0.96; SP=4.5/5 +/- 0.52) possibly due to the juxtaposition of the HPS vs. the SP, still considered the highest fidelity simulator currently available. The HPS/SP combination was an effective teaching method. (4.19/5 +/- 0.6) Trainees were able to transition smoothly between the HPS and the SP (4.26/5 +/- 0.81).

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Human Patient Simulation becomes widely used in teaching and training medical students and health care professionals. There have been identified 158 simulation centers which provide training for undergraduate medical students. Different scholars use different approach to simulation and use different methods of assessing the effectiveness of simulator based teaching. The LSUHSC, School of Medicine at New Orleans has developed and implemented an innovative one year long Human Patient simulation core curriculum for junior medical students based on the principles of adult teaching and learning through inquiry with use of Human Patient Simulator (HPS) developed by METI, inc.. Each junior student undergoes eight sessions with the simulator learning to manage complex medical problems before encountering them in real world. This program covers the following conditions: acute thermal injury, acute upper GI bleeding, tension pneumothorax, CHF, atrial fibrillation, acute asthma attack with severe bronchial obstruction, septic shock, and eclampsia.

Each simulation session has a set of case specific learning objectives which need to be accomplished to reach a successful outcome of the case. All interventions are structured into case-specific critical pathways that determine the following progression of the scenario. Instructor's role during the case is limited to entering into the computer data that the simulator cannot automatically recognize. This method allows creating realistic "student-to-student" and "student-to-simulator" communications known as social realism. There are also other techniques used to enhance contextual immersion of the trainees: physical realism, ability of the environment to change in response to the students' interventions, using effect of "transportation," as well as real life conventions in simulated environment etc.

The learning objectives of each simulation case are developed with taking into consideration the level of students' prior knowledge, pathophysiological processes of a given medical condition and technical capabilities of the HPS.

To assess the effectiveness of the sessions, there were designed paired pre- and post-activity multiple choice question tests whose questions were focused on the learning objectives of the case. The knowledge gain was measured and the difference between the scores in pre- and post-activity tests. Paired t-test was performed to examine the difference. Complete data were available for pre- and post-test total scores for 280 medical students across 6 medical scenarios that include the following: MED-Atrial Fibrillation (N=56), MED-CHF (N=10), PED-Asthma (N=63), PED-Septic shock (N=28), OB-Eclampsia (N=63), SUR-GI bleeding (N=56). The overall difference between pre- and post-test scores, which indicated the knowledge gain, was significant with  $p < 0.0001$ .

Conclusion: Obtained data reveal that method of teaching through inquiry in conjunction with Human Patient Simulator allows creating reach learning and teaching environment for junior medical students in which they can effectively to organize their knowledge of basic sciences into the patient care protocols.

## Leadership behavior, but not attitude, changes in response to short term team training

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### Introduction

In this exploratory case study our hypothesis was that trainees' leadership performance improves and attitudes changes in response to trauma team training using five scenarios in a patient simulator environment.

### Methods

Fifteen medical students (8 females and 7 males, range 21.8 to 25.3 years) without earlier experience of trauma or team training at the end of their fifth semester were recruited to the study. The course started with four separate lectures during three hours in: surgical trauma, orthopedic trauma, assessment of vital functions using the model A-B-C-D-E, and team work. The participants were familiarized to the patient simulator (HPS®, METI, FI, USA) environment by learning how to carry out a primary survey. All students were requested to answer questionnaires on self-efficacy (SE-scale) (1), and attitudes, (OTRMS) (2). In a pre-test trauma scenario students acted as team leader. Immediately after the pre-test scenario students were presented a questionnaire on engagement modes (EM-scale) (3). During the training period the following day each students was active observer in two scenarios, acted as team member in two scenarios and as team leader in one scenario. Feedback was given during a debriefing session using video recording after each of the five training scenarios. The last day all subjects experienced a post-test scenario as team leader and were presented the same questionnaires as before and after the pre-test. Pre-test, training and post-test scenarios were all video recorded and behavioral performance analyzed using the Emergency Medicine Crisis Resource Management Scale (4) by three raters. The videos recordings from the three active training scenarios will also be analysed.

### Results

Only one of the 18 items in OTRMS changed significantly. Eleven of twelve behavioral components of leadership were significantly higher in the post-test scenario. Data from the three training scenarios will be presented.

### Discussion

Findings that almost all behavioral components of leadership were significantly higher after scenario-based training indicate that the course was able to improve behavior, but not attitudes.

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# Assessment of team training using Engagement Modes and Self Efficacy

<sup>1</sup>76

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## Introduction

Improvement in student motivation and team performance may be attributed to the professional training activity during scenario-based trauma team training using a patient simulator environment. Our hypothesis were that trainees a) experiences such as flow experiences and mental strain changes, b) individual characteristics such as engagement modes and self-efficacy changes, c) and that there are positive relationships between students' engagement modes, self-efficacy, and leadership performance in the process of scenario training.

## Methods

The design of the study has been described elsewhere (Meurling et al, 2005 IMMS meeting). In short 15 medical students were recruited to a trauma team course for novices. Data were sampled for each individual in connection to a pre-test scenario, three training scenarios, and a post-test scenario. Flow was monitored using a 16 item version of the flow-scale (1). Mental strain was controlled by using the CR10 scale (2). For assessing a student's characteristic reactions to the simulator environment, scenarios and team work, we used a Swedish version of the EM-scale with 23 items (3). We used a subscale to the motivated strategies for Learning Questionnaire (MSLQ), constructed to assess students' perception of self-efficacy. All scenarios were video recorded and behavioral performance analyzed using the Emergency Medicine Crisis Resource Management Scale.

## Results

Overall Flow was significantly lower during training for the first time as compared to the pre-test ( $p = 0.011$ ) and increased during the training scenarios and the post-test. The index for mental strain showed a similar pattern. For females negative engagement modes as Frustration/Anxiety was reduced in response to training ( $p = 0.026$ ), while for males positive engagement modes increased significantly ( $p = 0.046$ ). For females only there was a significant heightening of self-efficacy ( $p = 0.050$ ). Males had a higher and stable self-efficacy over the study. Positive, significant correlations (Spearman's rho) were found between indices for positive engagement modes and self-efficacy ( $p = 0.042$ ), and overall flow ( $p = 0.032$ ), and between self-efficacy and overall flow ( $p = 0.016$ ). There were no significant correlations between self-efficacy, flow experience, mental strain and leadership performance. A positive trend was found between positive engagement modes and leadership performance ( $p = 0.061$ ).

## Discussion

All trainees, and in particular females, experienced more flow and were more challenged during the later training sessions as compared to the first and second session. Presumably, they felt more comfortable with and positively challenged by the training situation (scenarios, tasks and feedback) as training continued. The present model based evaluation tools, Engagement Modes and Self Efficacy, designed for assessment of training seems to be promising for future summative and formative evaluation.

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## The BIG Shock – AED Trials for Non-Experienced Responders

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In the spring of 2004 University of Pittsburgh Medical Center (UPMC) Health System committed to placing AEDs at over 200 of its facilities including physician offices, business and corporate offices, physical therapy sites. The committee needed to decide which AED would best meet the needs of all sites. An expert panel was formed and established the desirable characteristics of the AED. They then needed to test whether the potential AEDs met the desirable characteristics.

### Methods.

**Setting:** UPMC, Peter M. Winter Institute for Simulation Education and Research (WISER), Medical Education Theaters. Each theater contained one full scale simulator, Laerdal SimMan, a bed, full scale audio and video capabilities.

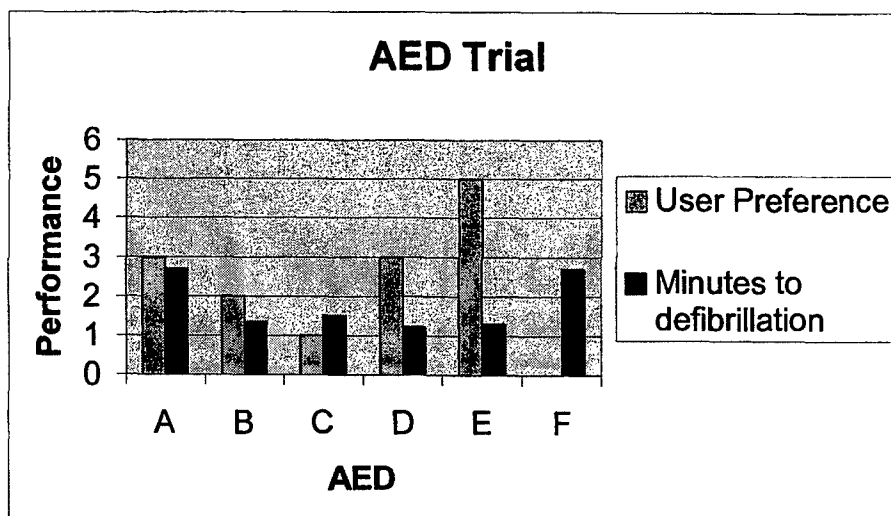
**Participants:** Fourteen untrained volunteer lay people who had never used an AED evaluated 2 of 6 AEDs selected by the committee.

**Procedure:** Facilitators informed each participant that we would be evaluating the ease of use of randomly chosen AED's, recording their performance data, and then questioning each subject about the functionality of the devices. Each participant was informed about the simulation setting. Finally, participants were told the victim was unconscious and needed the AED. They were then given the AED. At this time, the timed observation began. Primary endpoint was time to defibrillation. Secondary endpoint was user satisfaction.

Trained observers (3) utilized a 9- point AED Trial Evaluation Tool (ATET) constructed by the evaluation committee to record participant performance.

### Results.

**Conclusions.** 1. It is possible to utilize full scale human simulation to assess AED skills of untrained subjects. 2. By coupling time to defibrillation with user preferences, we were able to construct an efficiency rating, a learning curve, and a composite score for performance and preferences of users. 3. This helped us purchase the "right" equipment for our facility. A similar methodology may be useful elsewhere.



User preference and time to defibrillation for 14 individuals using three of six automatic external defibrillators

**Management Interface - Simulation: a web based calendar and resource reporting system for simulation centers**

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**Introduction**

Management of simulation resources, facilitators, and learners is a difficult task. In order to facilitate oversight in our simulation center, the Duke University Human Simulation and Patient Safety Center developed MIsim (Management Interface – simulation). MIsim

(<http://simcenter.duhs.duke.edu/calendar/>) is a World Wide Web application that combines the traditional services of a reservation calendar with a sophisticated reporting system that tracks facilities, facilitators, learners, and resources. The MIsim platform is easy to use for clients requesting reservations, staff responding to and facilitating those requests, and administrators overseeing and managing simulation center resources.

**Methods**

MIsim is database driven and is based upon internet standards such as PHP and SQL. MIsim is delivered to any web browser and allows client customization. MIsim may be run locally by a simulation center or hosted from a central location.

**Discussion**

MIsim allows the Duke University Human Simulation and Patient Safety Center to closely monitor and manage its facility, resources, learners, facilitators, and invoices.

The platform allows an end-user to quickly check for and request free simulation time in the HSPSC via the World Wide Web. The information submitted on the web is entered directly into the MIsim database. An email is automatically sent to the center's coordinator and director alerting them of the request. Once the coordinator approves the activity, it is published in the public calendar.

MIsim includes a password protected area where customizable administrative reports are produced and platform access is managed. MIsim includes a sophisticated search interface as well as predefined report templates. One such template is the "global activities" summary that aggregates simulation time, equipment and personnel into an easy to read report. Important variables found in the report include: 1) the amount of time (and day of week) each room of the simulation center has been used, 2) a tally of facilitator and learner times spent in the center, 3) simulation equipment used, and 4) simulation scenarios taught. The report may be constrained to a specific block of time.

Each facilitator and learner's name in the global report is hyperlinked to a report for that individual. The individual reports include the same information as the general report but limited to the individual. Each personalized report includes a list of hyperlinks back to the original database entries. The entire MIsim database can be exported as a tab delimited file then imported into a spreadsheet for further analysis.

Future enhancements to MIsim include the ability to embed learning objectives, link to digitized video, and aggregate assessments.

**Conclusion**

MIsim has become an indispensable tool in the operation and oversight of the Duke University Human Simulation and Patient Safety Center. We are seeking collaborators to enhance the functionality and portability of MIsim to other simulation centers.

## Simulating an Airway Fire With the METI HPS-010 Mannequin

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### Introduction

Airway fires are a rare but potentially life threatening situation. The anesthesia care team must react quickly to prevent catastrophic injury. All anesthesia care providers are expected to know how to properly manage this situation. High fidelity simulators such as the METI HPS can help train medical personal in these high acuity- low frequency situations. Currently, there are no commercial simulator scenarios involving airway fires. We have designed a simulator scenario with the METI HPS- 010 mannequin, to allow our residents to train in airway fire management.

### Scenario

A 21 year old male is undergoing an elective tonsillectomy. Additional props needed are a Mayo stand, an ENT ETT mouth gag, a Bovie unit, irrigation and various surgical instruments. A specially prepared "tension pneumothorax bladder", filled with a small piece of dry ice (fig. 1), has been situated in the side of the mannequin's mouth (fig. 2). The tubing from the bladder is inserted into a standard pilot cuff tubing and a syringe of warm water is attached to the valve. The mannequin is intubated with an endotracheal tube that has a "burn" hole cut into its side (fig. 3), that is occluded with a small piece of tape (fig. 4). During the tonsillectomy, the surgeon, while pretending to use the Bovie unit, removes the tape from the hole in the tube. With the hidden syringe, surgeon injects warm water into the bladder containing the dry ice. The effect: large airway leak and "smoke" coming from mannequin's mouth. The anesthesia team is expected to provide standard of care treatment for an airway fire.

### Materials and Methods

The following materials were used in the assembly of the airway fire simulation device:

- 7.0 endotracheal tube (Mallinckrodt) with 1cm hole cut in side at 15cm, taped closed
- Pilot cuff and tubing cut from an endotracheal tube
- "Tension pneumothorax" bladder from HPS-010, with a 2cm slit cut in the side
- Small pellet of dry ice and a large syringe of warm water.



fig 1.



fig 2.



fig 3.



fig 4.

### Discussion

Simulators can help in training of medical personnel in high acuity low frequency situations. The METI HPS provides many standard scenarios, including many other high frequency low acuity situations. However, airway fire, is understandably not represented. We have demonstrated that with a few simple modifications, (and a little creativity) the METI HPS-010 mannequin can be modified to meet other education needs. We have received positive feedback from our residents regarding the realistic nature of our scenario.

## A wireless syringe detection device. More fidelity and realistic drug application in Meti's simulators

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We present a wireless syringe detector for drug applications. Standard syringes are used and the detector is clipped to the syringe. Once the drug in the syringe has been identified on a separate computer, every movement of the syringe piston is automatically detected and calculated to the real amount of drug administration. This amount is then automatically sent to the model host as if the drug would have been entered manually. In the base station the batteries of the detector can be recharged. Lifetime of the batteries is several hours. One can use several detector devices in parallel. They are unique coded and the receiver handles this. This device gives more fidelity in HPS because the injection can take place at any iv-line and it allows for automatic drug recognition in the ECS. During the demonstration the device can be used and tested.

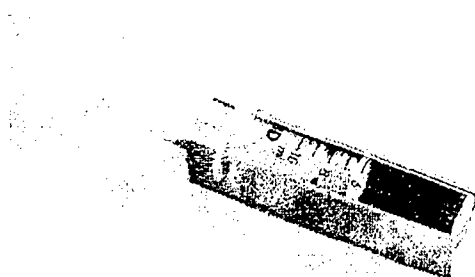


Fig. 1 Standard syringe in wireless detector



Fig. 2: Receiver, Battery charger and system for the identification of the drug used.



## Human Patient Simulation via Internet Based Video Teleconferencing

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Simulation technology has had multiple applications in medical education during the past 10 years and there is evidence to support the use of Internet based teleconferencing technology in diagnostic, surgical and all other ramifications of medical education.

**OBJECTIVE-** We present a method of interactive education in Anesthesia using realistic human patient simulation (HPS) on the (METI Adult HPS serial number HPS074, Medical Education Technologies inc.) over Apple's iChat AV (a new feature of Mac OS X version 10.3 "Panther"), a personal video conferencing software.

**METHODS-** Two centers were involved in this project: St Louis University's life support skills center (Center 1) and Creighton University's Department of Anesthesiology (Center 2). Both centers were equipped with Apple's Macintosh Powerbook G4 computers (PB G4), running Mac OS X version 10.3 "Panther". At Center 1, the audio/video (AV) feed from 2 theater cameras is mixed with the video feed from the HPS monitor using Panasonic Digital AV Mixer (Model WJ-MX 50A) and the analog signal is converted to digital AV stream using an analog to digital converter (Formac studio DV, FSD2050-0). The digital AV is then streamed to Center 2 over the Internet using the PB G4 and iChat AV software. Center 2 AV feedback is played through a large screen monitor in the simulation theater at Center 1.

At Center 2, a mini DV camcorder equipped with Fire wire connection or Apple's i-Sight web cam feeds digital AV signal to the PB G4. Center 1 AV feedback is projected on a large screen using the Epson ELP 7250 LCD projector. After establishment of a reliable connection using iChat AV, the residents in both centers are given the same case scenario with role playing such that the "Anesthesiologist" in Omaha, Nebraska (Center 2) and the "resident" in Saint Louis Missouri (Center 1). Together these two residents acting their given roles try to treat the patient in the given scenario.

**CONCLUSION-** This method is innovative because it provides an opportunity for the expansion of very expensive simulation technology to multiple centers that couldn't otherwise afford it and it can potentially expose a lot of health professional to the educational advantages of Simulation technology.

## A CRICOID PRESSURE TRAINER DESIGNED TO IMPROVE AIRWAY MANAGEMENT

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Flinders University, Adelaide, Australia

Department of Anaesthesia and Pain Medicine

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Task analysis of airway management training has revealed cricoid pressure teaching should be included but its importance is often overlooked. Cricoid pressure is recommended during CPR to avoid gastric distension during artificial ventilation (AHA 2000 Guidelines) and is also widely used in anaesthesia prevent aspiration of stomach contents during induction of anaesthesia and intubation. Applied correctly cricoid pressure is lifesaving but if misapplied it can contribute to adverse outcome. Overzealous application of cricoid pressure can cause difficulty in ventilation and intubation and may even make them impossible.

Practising how to overcome difficulty with airway management and intubation is a major use of simulators in anaesthesia and emergency medicine. Studies of basic and advanced airway management simulators and whole body manikins have revealed none of those in widespread use have the features necessary to teach effective and safe correct cricoid pressure. It appears that far more effort is directed towards training how to manage the adverse effects of incorrect cricoid pressure than teaching how to apply cricoid pressure correctly!

The health professional applying cricoid pressure must:

- Know when to apply and when to release cricoid pressure
- Have no other jobs
- Be able to reliably locate cricoid cartilage
- Be able to apply force in correct direction
- Be able apply correct force
- Be able to maintain correct force
- Be prepared for unusual or abnormal events

Several studies have revealed that most staff do not perform cricoid pressure well and there has been litigation against anesthesiologists and others over cricoid pressure not being applied correctly. Cricoid pressure is apparently simple but actually difficult to reliably apply safely and effectively. The rationale for teaching staff to apply 20-30N force to the cricoid will be presented and why more than 40N must be avoided. Airway management teaching should "Best Practice" cricoid pressure technique. Initial training is important but regular practise in the workplace is also needed to maintain the skill. A compact and inexpensive cricoid pressure trainer developed by the authors will be demonstrated.

Ensuring appropriate simulation fidelity is the essential element of medical simulation. Primary factors that contribute to simulation fidelity include the manikin or other hardware that serves as the simulator and the capabilities of the software that endows the simulator with realistic characteristics and responses. But, even the most complex simulator and simulation software will not generate, a priori, high fidelity simulation unless appropriate attention is paid to other aspects of the simulation environment. These aspects include the provision of necessary medical equipment and supporting actors as well as



realistically constructed scenarios. Finally, in the context of patient safety research and training, the software system must allow the investigator/instructor to quickly and accurately document care providers' actions. Typically, complex simulations with high fidelity translate into higher costs. But, not all organizational budgets can accommodate complex simulators and the costs of their maintenance and support.

Among employees in safety sensitive occupations, the two most prevalent forms of performance deficits are fatigue and alcohol-related impairments, whether intoxication or hangover. We are studying whether routine levels of fatigue and alcohol hangover among certified practicing Emergency Medical Technician-Paramedics (EMT-Ps) impair judgment and/or performance in such a way that patients who are reliant on the medical resuscitation and stabilization skills of EMT-Ps are placed at unacceptable risk as a consequence of these impairments. The specific aims of the study are to : 1) Examine EMT-P performance on standard cognitive and psychomotor tasks known to be sensitive to fatigue from partial sleep deprivation as well as low blood alcohol concentration (BAC), or alcohol hangover; and 2) Validate the sensitivity of a rescue skill-specific programmable instrumented manikin-simulator with assessment protocols known to be sensitive to fatigue and hangover, and determine the extent to which the simulation can detect areas of task-relevant impairment among EMT-Ps when they are fatigued: a) toward the end of typically long work shifts of 24 hours; and b) when they are coming onto a shift following moderate alcohol use that produces hangover symptoms 6 or more hours later.

The proposed poster will describe the evolution of an instrumented manikin simulator system, which is in use to explore patient safety issues in prehospital resuscitative care by EMT-Ps. This system is well within the fiscal reach of smaller organizations yet facilitates robust simulation. The poster will describe the features of the manikin simulator, the software system which drives it and enables recording of subjects' actions, the development of the algorithms for use in the scenarios of the study and other essential external features of the simulation such as staffing the simulation with appropriate actors and staging the actors to augment realism. Each of these factors, contribute to the overall fidelity of the simulation. The manikin simulator and tablet PC-run simulation software will be displayed and available for demonstration. Finally, the poster will include very early findings from the EMT-P patient safety study.

# IMMS PROGRAM NOTES

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*Society for Medical Simulation*  
*Improving patient care through*

*medical simulation*

A new society, the Society for Medical Simulation (SMS), has been established in January 2004 to represent the rapidly growing group of educators and researchers who utilize a variety of simulation techniques for education, testing, and research in health care. The membership is united by its desire to improve performance and reduce errors in patient care using all types of simulation including task trainers, human patient simulators, virtual reality, and standardized patients.

We are a broad-based, multi-disciplinary, multi-specialty, international society with ties to all medical specialties, nursing, allied health paramedical personnel, and industry. A major venue for advancing simulation in medicine is the annual International Meeting for Medical Simulation (IMMS) that has been held successfully since 1995. SMS beginning in 2006 will wholly sponsor this meeting.

SMS welcomes ties with other organizations interested in patient simulation. Recognizing that simulation represents a paradigm shift in health care education, SMS promotes improvements in simulation technology, educational methods, practitioner assessment, and patient safety that promote better patient care and can improve patient outcome.

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